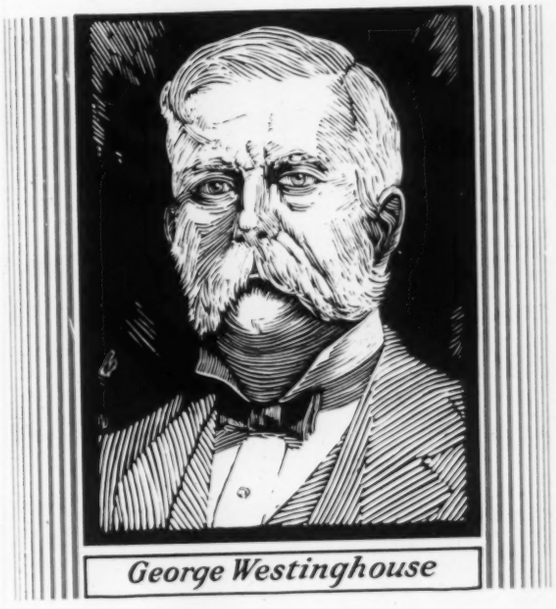
SEP 15 193

SEPTEMBER 1933

MACHINE DESIGN



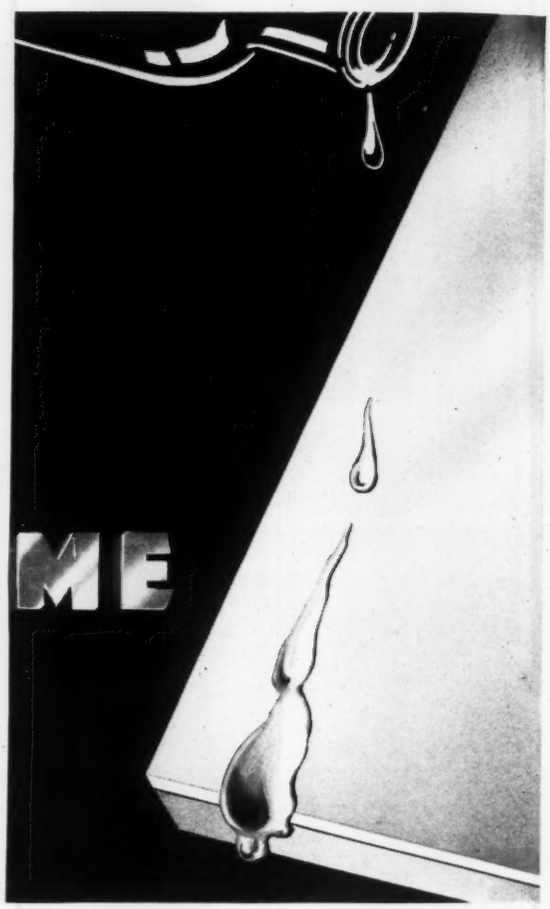
George Westinghouse

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

For Any Application Where Corrosion Resistance is Needed on One Side

USS PLYKROME



PLYKROME offers, at low cost, all of the advantages of Stainless Steel in any installation where corrosion resistance is required only on one side of a plate. For tanks, pressure vessels, food containers, cooking vats and a host of other types of equipment, Plykrome is the ideal metal.

Plykrome is coated on one side with a layer of USS 18-8 Stainless Steel—completely inert under most acids and alkalies . . . resistant to atmospheric corrosion . . . suitable for many high temperature applications. Write today for complete information and advice as to the application of Plykrome to your requirements.

Illinois Steel Company

208 SOUTH LA SALLE STREET, CHICAGO, ILLINOIS

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

U S S CHROMIUM-NICKEL ALLOY STEELS ARE PRODUCED UNDER LICENSES OF THE CHEMICAL FOUNDATION, INC., NEW YORK, AND FRIED. KRUPP A. G. OF GERMANY

Itemized Index September, 1933

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

Design Calculations:
Differential gearing, Edit. 12, 13, 14, 38

Design Problems:
Consumers' desires, anticipating, Edit. 41
Drives, developing efficient, Edit. 11, 12, 13, 14, 38
Gears, determining performance of, Edit. 15
Intermittent motion, securing, Edit. 37, 38L, 46L
Machine finishes, specifying, Edit. 23, 24
Materials, selecting, Edit. 25, 26, 27, alloy supplement
Pressures, balancing, Edit. 15R, 16L
Shock, absorbing, Edit. 16R, 17L
Steel, selecting alloy, Edit. 28, 29, 30, 31, 60R
Varying conditions, combating, Edit. 32, 33
Welding, designing for, Edit. 18, 19, 20, 21, 22

Finishes:
Machine, Edit. 23, 24

Materials:
See Alloy Directory published as a supplement to this issue
Alloys (Hard-Facing), Adv. 9
Alloys (Nickel), Edit. 26, 27L, 28, 29, 30, 31, 60R; Adv. 53
Alloys (Steel), Edit. 25, 26R, 27L
Aluminum, Edit. 26R
Brass, Edit. 27
Bronze, Edit, 26R, 27R
Copper, Edit. 17R
Steel (Metal-Clad), Adv. 2
Zinc, Adv. 67

Mechanisms:
Disengaging, Edit. 45
Driving, Edit. 11, 12, 13, 14, 38
Painting, Edit. 45R, 46L
Reversing, Edit. 37, 38L
Shock absorbing, Edit. 16R, 17L
Spring, Edit. 25R, 26L

Organization and Equipment:
Bonus systems, Edit. 37L
Engineering department, Adv. 63R

Parts:
Bases, Edit. 19R, 20, 21, 22L
Bearings, Edit. 56R; Adv. 4, 47, 51, 54L
Cast parts, Edit. 28, 29, 30, 31, 60R
Clutches, Edit. 33R; Adv. 62L
Controllers, Edit. 58R
Controls (Electrical), Edit. 58R, 59L; Adv. 68
Conveyors, Adv. 3
Cord (Electrical), Edit. 50
Couplings, Edit. 45, 50L, 56R, 57L; Adv. 58L
Drives, Edit. 11, 12, 13, 14, 33, 38; Adv. 3, 64
Electronic equipment, Edit. 17, 50R, 52L, 54R, 56L
Fastenings, Edit. 26, 27R, 50R; Adv. 56L, 61R, 65R
Gears, Edit. 11, 12, 13, 14, 15, 38
Heating units, Edit. 52R, 54R; Adv. 59R
Instruments, Edit. 52L, 57L, 58R
Lubrication and lubricating equipment, Adv. 6
Motors, Edit. 52R, 54R, 59L; Adv. 10, 57R, 66
Plugs (Electrical), Adv. 49
Pumps, Adv. 62L
Shapes, Edit. 18R, 19, 20, 21, 22L
Springs, Edit. 25R, 26L, 39
Stampings, Adv. 64L
Valves, Edit. 52
Welded parts and equipment, Edit. 16, 18, 19, 20, 21, 22

Principles:
Hydraulic, Edit. 46

Production:
Machine finishes, specifying, Edit. 23, 24
Materials, influence on, Edit. 25, 26, 27

Sales and Sales Department:
Appearance, designing for, Edit. 23, 24, 41
Visibility, providing, Edit. 17L

STANDARD gearing has been received with such enthusiasm recently that the average designer is apt to lose sight of the fact that for certain purposes gears with nonstandard involute teeth have advantages which may make them the most advantageous for the job at hand. Inasmuch as most gears have their entire useful life in the machine for which they were made, the value of standardization lies in the use of standard methods as James A. Hall and Harold S. Sizer will bring out in their article in the September issue.

Calendar of Meetings and Expositions

Sept. 7-23—Twelfth Shipping, Engineering and Machinery Exhibition. To be held at Olympia, London, England. Information may be obtained from F. W. Bridges & Sons Ltd., Grand Buildings, Trafalgar Square, London, W. C. 2, England.

Sept. 22-30—Electrical and Radio Exposition. Post-depression show under the auspices of Electrical Association of New York to be held at Madison Square Gardens, New York.

Sept. 23-Oct. 1—Second American Exposition of Brewing Machinery, Materials and Products. To be held in the Coliseum and Annex, Chicago, during the meeting of the Master Brewers' Association of America. Felix Mendelsohn, Auditorium hotel, Chicago, is managing director of the exhibition.

Sept. 26-28—Technical Association of the Pulp and Paper Industry. Fall meeting is to be held at Appleton, Wis. R. G. Macdonald, 370 Lexington avenue, New York, is secretary of the association.

Oct. 2-6—National Metal congress. Annual exposition of machines, materials and parts to be held at Convention Hall, Detroit. Information may be obtained from W. H. Eisenman, 7016 Euclid avenue, Cleveland.

Oct. 2-6—National Safety council. Twenty-second annual safety congress and exposition to be held at Stevens hotel, Chicago. W. H. Cameron, 20 North Wacker drive, Chicago, is managing director of the council.

Oct. 2-6—American Society of Mechanical Engineers. Annual meeting of machine shop practice division to be held in Detroit will include a paper on "Simplicity—the Solution of Extreme Accuracy in Quantity Production," by Gordon M. Evans. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

Oct. 2-6—American Welding society. Thirteenth fall meeting to be held at Book-Cadillac hotel, Detroit, will include papers on "Physical Properties of Welded Cast Steel," by Chas. H. Jennings; "Fatigue of Metals," by G. E. Thornton; and "Internal Stresses in Welds," by C. T. Schwarze. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

Oct. 2-6—American Society for Steel Treating. Exposition and fifteenth annual meeting to be held at Convention Hall, Detroit, will include papers on "An Inquiry into Deformation of Steel by Tensile Stress and the Interrelation of Deformation to Other Physical Properties," by E. J. Janitzky; "Some Factors Affecting the Physical Properties and Corrosion Resistance of 18-8 Chrome-Nickel Steel Wire," by W. H. Wills and J. K. Findley; "Alloys of Iron and Manganese," by F. M. Walters, et al.; and "Structure and Constitution of an Alloy Steel," by O. W. Ellis. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary of the society.

Oct. 2-6—American Institute of Mining and Metallurgical Engineers. Annual meeting of the Iron and Steel and Institute of Metals divisions to be held at Detroit. A. B. Parsons, 29 West Thirty-ninth street, New York, is secretary of the institute.

Oct. 9-13—American Bottlers of Carbonated Beverages. Annual meeting and exposition of equipment to be held in the Jefferson County Armory, Louisville, Ky. Junior Owens, 726 Bond building, Washington, is secretary of the society.

Oct. 16-19—National Business Show. Exposition of business machines and similar equipment to be held at New York. Information may be obtained from E. Tupper, 50 Church street, New York.

Oct. 17-19—Association of Iron and Steel Electrical Engineers. Mechanical, combustion, lubrication, electrical and safety division meetings, twenty-ninth annual convention and iron and steel exposition to be held at Wm. Penn hotel, Pittsburgh. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director of the association.

Oct. 23-28—Motor and Equipment Manufacturers' association. Annual exposition to be held at Merchandise Mart, Chicago. C. C. Secrist, 5750 Roosevelt road, Chicago, is secretary of the association.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
September, 1933 Vol. 5—No. 9

Smaller Drive Is Feasible with Differential Gears

By Ray T. Congleton
Congleton Engineering Co.

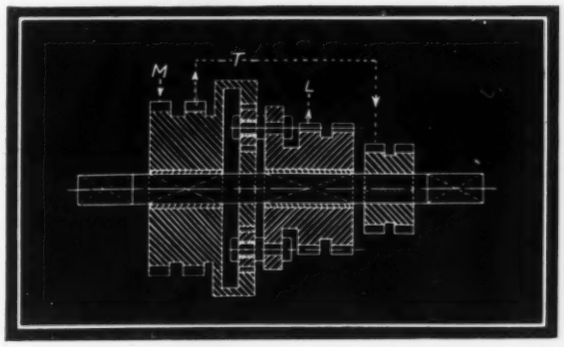
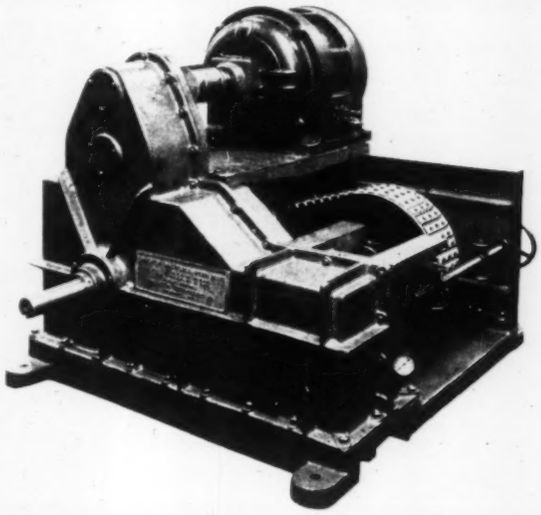


Fig. 1—There are twelve workable ways in which the motor, the load, the transmission and the gearing may be connected

Fig. 2—It is possible to employ a transmission of smaller capacity when it is connected with special gearing



ADJUSTABLE transmissions have been in extensive use for some time and so are familiar to the industrial fraternity. These machines commonly are referred to as "variable speed transmissions." However, the word "variable" can be considered as applying to characteristics that may change under varying operating conditions independently of the control of the operator. A characteristic that responds to the control of the operator and remains constant, or practically constant, regardless of changes in operating conditions, is said to be "adjustable." These so-called "variable speed transmissions" are, therefore, more properly "adjustable speed transmissions."

This discussion will be based on the type of adjustable ratio transmissions shown at *X*, Fig. 3, but in general the remarks will apply equally well to other types such as hydraulic. For the type being considered, the capacity depends upon

the lineal speed at which the belt travels and upon the arc of contact of the belt on the conical pulleys. With the input shaft driven at a constant speed the following conditions prevail:

Minimum output speed is obtained when the belt operates on the smallest diameter of input pulley and the largest diameter of output pulley

Maximum output speed is obtained when the belt operates on the largest diameter of input and smallest diameter of output pulley

$$\frac{\text{belt speed at max. speed}}{\text{belt speed at min. speed}} = \sqrt{\frac{\text{max. speed}}{\text{min. speed}}}$$

Therefore,

$$\frac{\text{HP at max. speed}}{\text{HP at min. speed}} = \sqrt{\frac{\text{max. speed}}{\text{min. speed}}}$$

For example, a transmission with a range of from 100 to 1600 RPM and a capacity of 2 horsepower at the minimum speed, would have a capacity of $2 \times \sqrt{1600/100}$ or 8 HP at the maximum speed.

The ratio of maximum to minimum speeds is the square of the ratio of maximum to minimum effective belt diameters of the pulleys. If the effective belt diameters of the pulleys are 3 inches for a minimum and 12 inches for a maximum, the maximum speed is 16 times the minimum, the maximum speed of the varying speed shaft being 4 times the speed of the constant speed shaft and the minimum speed of the varying speed shaft being one-fourth the speed of the constant speed shaft. Speeds approaching zero obviously are impossible because they would require effective belt diameters approaching zero. It also is apparent that, with a unidirectional rotation of the input shaft, the rotation of the output shaft must be unidirectional.

With this type of transmission it is evident that all of the power delivered to the load by the output shaft must be handled by the transmission. Faced with an application in which the physical dimensions of the transmission required were so large as to make the installation impossible, the writer reasoned as follows: At maximum speed a certain power is required. At minimum speed a smaller amount of power is required. The variable part of the power is the difference between that required at maximum and that required at minimum speeds; yet the transmission must handle the full power at all speeds. If some way can be devised for shunting around the transmission that constant component of power which is required under all conditions, then the transmission will handle only that component of power which is variable and the required capacity of the transmission will, thereby, be reduced.

As a result of this reasoning an arrangement of an adjustable ratio transmission in connection with a differential planetary gearing was developed. A 40 HP machine of this type, together with its constant speed motor, is shown in Fig. 3. The cover has been removed for convenience. Inset shows the reverse of gear *C*.

Gear Is Fully Bearinged

In this arrangement gear *C* carries a bearing shoulder which abuts against one side of sprocket gear *J*. The other side of this sprocket gear abuts a bearing shoulder on a spider plate, not shown. Sprocket gear *J* is bearinged on the shoulder of the spider plate and gear *C*. Planet gears *P* are mounted on shafts which are bearinged in gear *C* and in the spider plate. The planet gears engage sun gear *S*, keyed to the output shaft, and sprocket gear *J*, connected by chain to sprocket *H*.

Gears *A*, *B* and *C* are driven at a constant speed by the motor, *A* and *B* being merely auxiliaries through which the motor is connected to *C*. Gear *C* is bearinged to rotate freely on output shaft *D*, the speed of which is adjustable. *E* and *F* are the conical pulleys of the transmission, their effective belt diameters being simultaneously varied at will by means of handwheel *G* and its connecting mechanism. Pulley *E* is splined to shaft *D* and pulley *F* is splined to the shaft which carries chain sprocket *H*. The sun gear, planet gears and the sprocket gear form a planetary differential gear

TABLE I

Possible Combinations of Differential Gear and Transmission Connections

Case	Power through transmission passes: From	To	Load attached to	Motor applied to	Stationary gear	Load is handled by
1	t_c	t_s	t_d	t_c	sun	internal gear
2	t_c	t_d	t_s	t_c	planet spider	internal gear
3	t_d	t_s	t_c	t_d	sun	planet shafts
4	t_d	t_c	t_s	t_d	internal	planet shafts
5	t_s	t_d	t_c	t_s	planet spider	sun gear and internal gear
6	t_s	t_c	t_d	t_s	internal	sun gear and planet spider
7	t_s	t_d	t_d	t_c	sun	internal gear and planet shafts
8	t_d	t_s	t_s	t_c	planet spider	internal gear and sun gear
9	t_s	t_c	t_c	t_d	sun	planet spider and internal gear
10	t_c	t_s	t_s	t_d	internal	planet spider and sun gear
11	t_d	t_c	t_c	t_s	planet spider	sun gear and internal gear
12	t_c	t_d	t_d	t_s	planet spider	sun gear and internal gear

system in which all three elements can be, and in practice are, in rotation simultaneously. Their relative and absolute speed are dependent upon the speed at which the planet gears are driven by the motor through the gear train and the effective ratio by which sprocket gear J is connected to sun gear S through the chain drive and the adjustable ratio transmission. The planet gears are driven at a constant speed while the relative and absolute speeds of the sprocket gear and the sun gear are controlled by adjusting the transmission ratio. Since shaft D is fixed to the sun gear, its speed is adjustable to the same extent as that of this gear.

Full power of the motor is delivered to the planet gears P through A, B and C. (For the sake of simplicity losses are neglected). Of the power delivered to the planet gears, the force component is divided into two equal parts, one part acting upon sun gear S and the other upon sprocket gear J. The combination of the force which acts upon the sun gear and the speed of rotation of this part results in a power component which is delivered to the sun gear and from there direct to the driven load through shaft D. The combination of the force which acts upon the sprocket gear and the speed of rotation of this part results in another power component. This power component is delivered to the sprocket gear and from there through the chain drive, sprocket H, and the adjustable speed transmission to shaft D and the driven load.

TABLE II

Maximum and Minimum Characteristics of Drive Arrangements

	Cases 1 to 6		Cases 7 to 12	
	(a)	(b)	(a)	(b)
Max. output speed/min. output speed	4.0	1.5	1.5	4.0
Conventional range of transmission required	16.0	2.67	2.67	16.0
Belt speed at max. output speed/belt speed at min. output speed	4.0	0.6	2.5	1.0
At max. output speed, HP_T/HP_L	0.8	0.2	0.8	0.2
At min. output speed, HP_T/HP_L	0.2	0.8	0.2	0.8
At max. output speed, HP output/max. HP of transmission	1.25	3.0	1.25	5.0
At min. output speed, HP output/max. HP of transmission	1.25	1.25	2.0	1.25

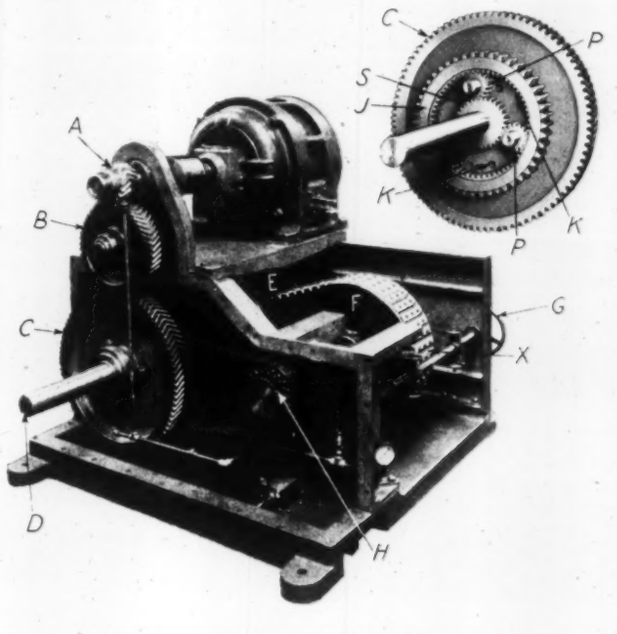


Fig. 3—All three elements in this drive arrangement can be, and in practice are, in rotation at one time

It thus can be seen that this combination produces an adjustable speed drive in which the transmission handles only a portion of the total power delivered to the load. A further advantage is obtained because it is possible to arrange the parts so that whether the output speed is maximum or minimum the belt of the transmission operates at its most efficient high speed. That is to say, the belt speed of the transmission (and therefore the capacity of the transmission) may be at the same high value for minimum or maximum speed of the output shaft. The ratio of the power delivered direct to the load to that delivered to the load through the transmission varies with the ratio of the speed of the sun gear to that of the sprocket gear. The conditions under which this ratio is high or low can be varied largely to suit the characteristics of the load to be driven.

Many Combinations Possible

A study of the various ways in which adjustable speed transmissions can be connected to differential gearing and the characteristics obtained by the combinations resulted in an analysis which proved that of the twelve possible arrangements the one here described is best for the result desired, namely, the shunting of part of the power from the motor direct to the load so that the size and cost of the transmission required to govern the speed of a given load is reduced.

Preliminary to the treatment of the gearing in combination with adjustable transmissions, consideration will be given to differential gearing in which all three elements are in rotation simultaneously. Such an arrangement is shown in Fig. 4.

This particular gearing is of the planetary type, but other types could be substituted without altering the principles. Bearinged at each end and free to rotate is a central shaft to which is rigidly fixed the sun gear and auxiliary gears or sprockets t_s by means of which the sun gear is rigidly connected to other mechanisms. Supported by the shaft and free to rotate about it are the spider which carries the planet gear and

the spider which carries the internal gear. These spiders also carry auxiliary gears or sprockets t_c and t_d by means of which the internal gear and the supporting spider of the planet gears are connected rigidly to other mechanisms.

In order to simplify the analysis, the pitch diameter of gears t_s is made equal to that of the sun gear, the pitch diameter of gears t_c is made equal to that of the internal gears, and the pitch diameter of gears t_d is made equal to that of the orbit of the planet gears. Further, the pitch diameter of the internal gear is made twice that of the sun gear, from which it follows that the pitch diameter of the planet gears is one-half that of the sun gear and one-fourth that of the internal gear, while the diameter of the orbit of the planet gears is 150 per cent of the pitch diameter of the sun gear. The use or relative diameters other than those assumed would alter

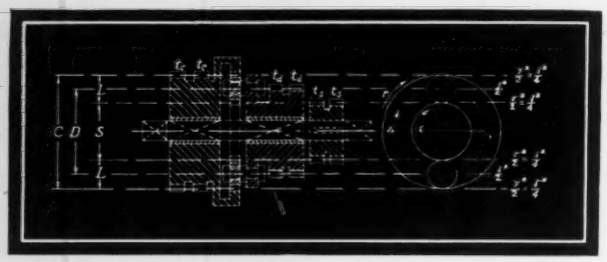


Fig. 4—Relative diameters other than those shown would not modify principles of analysis

the absolute angular and lineal speeds existing under a given power relationship but would not modify the principles of the analysis. Providing for later considerations of speed and force, let the following symbols apply to Fig. 4.

Parts	Diameter in inches	R.P.M.	Total net tangential force in pounds
Sun gear & t_s	S	Σ	$\sigma = 0.5\delta = \lambda = \gamma$
Planetary spider & t_d	$D = 1.5S$	$\triangle$	δ
Planetary gear	$L = 0.5S$	$\triangle$	$\lambda = 0.5\delta = \sigma = \gamma$
Internal gear & t_c	$C = 2.0S$	Γ	$\gamma = 0.5\delta = \sigma = \lambda$

The speed relations of the elements of the gearing under any conditions are determined by the following analysis:

If clockwise rotation be considered positive and if the rotation of the spider be zero, then,

$$S\Sigma = -C\Gamma$$

For other clockwise speed, $\triangle$, of the planet spider, the spider may be brought to rest without affecting the relative speeds of the sun gear, the planet gears, the spider and the internal gears by rotating the whole train backwards as a unit $\triangle$ RPM.

$$S(\Sigma - \triangle) = -C(\Gamma - \triangle)$$

or $$S\Sigma - S\triangle = C\triangle - C\Gamma$$

or $$(C+S)\triangle = S\Sigma + C\Gamma$$

or $$\triangle = \frac{S}{S+C}\Sigma + \frac{C}{S+C}\Gamma$$

or $$\Sigma = \triangle + \frac{C}{S}\triangle - \frac{C}{S}\Gamma$$

or $$\Gamma = \triangle + \frac{S}{C}\triangle - \frac{S}{C}\Sigma$$

Regardless of the absolute speeds of the various elements, the above relations hold true.

Any two of the three principal elements of the gearing may be connected together through the transmission. For a given setting, the two shafts of the transmission have a definite speed relation which would determine a corresponding speed relation between the two elements of the gearing to which the shafts of the transmission are connected. Since the speeds of all three elements are definitely related, the fixation of the speed relations of any two of the three automatically fixes the speed relations of all three. Therefore, by connecting any two elements by means of an adjustable transmission, the speed relations of all three elements are subject to control by adjustment of the transmission. Then, by connecting one of the elements to a constant speed power source, the control of the relative speeds of the elements of the gearing is converted into the control of absolute speeds of all three. Further, by connecting a load to either of the two elements to which the motor is not connected, the speed at which the load is driven is controllable by transmission adjustment.

Twelve Combinations Possible

There are twelve workable ways in which the motor, the load, the two shafts of the transmission, and the elements of the gearing may be connected. One of these twelve ways is shown schematically in Fig. 2 in which the motor is represented by *M*, the load by *L* and the transmission by *T*. In all cases and under all conditions it will be found that the power handled by one of the elements is equal to the load or the power received from the motor and that the power handled by another is equal to that handled by the transmission. The power handled by the transmission may be more or less than the total power delivered to the load; but in either case, the power handled by the third differential element is equal to the difference between the power delivered to the load and that handled by the transmission.

The total force acting on the planetary gears tangential to the orbit about which their centers rotate is δ; the diameter of this orbit is D and the speed of the gears in their orbit is $\triangle$; therefore, the HP handled by the gears and their spider is

$$HP_p = \pi D \triangle \delta \ / (12 \times 33{,}000)$$

The total force of the planet gears δ is divided into two equal parts $\delta/2$ which act on the sun gear and on the internal gear respectively.

The power handled by these gear is

$$HP_S = \pi S \Sigma \delta \ / (2 \times 12 \times 33{,}000)$$

And the power handled by internal gear is

$$HP = \pi C \Gamma \delta \ / (2 \times 12 \times 33{,}000)$$

Considering the first case noted in Table I, shown in Fig. 2, if the sun gear is stationary,

(*Concluded on Page* 38)

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Optical Gear Testing Simplified

MACHINES and equipment developed abroad frequently embody features which may be studied profitably by engineers here. Ideas along the lines of compactness, simplicity and rapid operation, for instance, may be found in an optical gear tester designed by Societe Genevoise d'Instruments de Physique, Geneva, Switzerland. This instrument, Fig. 1, is said to differ from most projection instruments in that it does not project an image of teeth of the gear, but throws on a graduated screen a rectangular shadow of a signal plate by which, on the horizontal ordinate of the screen, is read the variations of eccentricity of the gears and on the vertical ordinate the errors of pitch.

Gears to be tested are mounted on mandrels between adjustable centers that are supported on a heavy cylinder. Position of this cylinder can be adjusted according to the diameter of the gear by the rotation of a handwheel at the left of the instrument. A pair of interchangeable feelers is mounted on supports, to which a light spring pressure is applied to engage them between the gear teeth. Pitch measurements are made by the movement of one of the feelers with reference to the other. One feeler is carried on a floating arm which swivels to right and left and tilts up and down without any play. The other end of this arm carries a rectangular steel signal plate about 0.005-inch thick, with edges lapped square to each other.

This signal plate is sealed between two larger plates of glass to avoid any accumulation of dust on its edges. A condenser with a 50-watt light behind it projects the shadow of the rectangular signal plate onto the mirror and from thence to the screen. The instrument recently was introduced into this country by R. Y. Ferner Co., Washington.

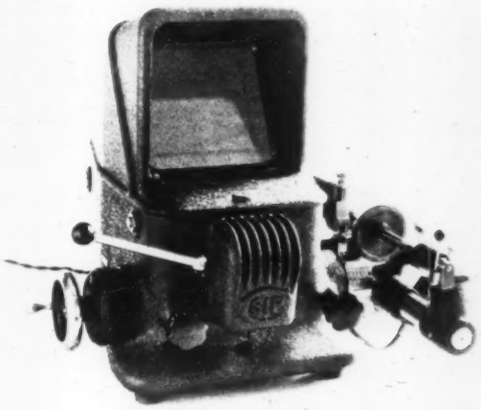


Fig. 1—Gear tester employs signal plate instead of tooth image

Electrifying the Small Machine

VIRTUALLY no machine, regardless of how small it may be, precludes electrification. The motor-driven razor blade sharpener, Fig. 2, is an example. Barely larger than a child's building block, this compact device embodies a patented worm gear drive. Uniform pressure exerted by each roll insures even sharpening of blades. When the cover is closed the motor starts. General Electric Co., Bridgeport, Conn., developed it.

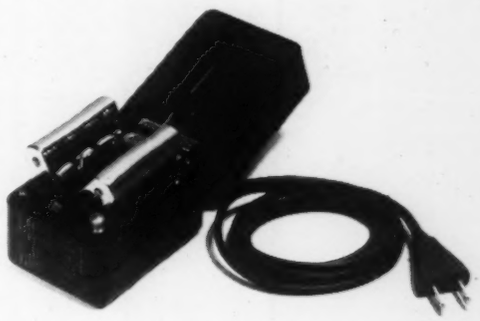


Fig. 2—Size presents no obstacle to the incorporation of a motor drive

Controller Utilizes Diaphragms

WHEN the designer is called upon to furnish a device that will maintain a fixed ratio between two pressures which characterize two separate flows of gas or other fluid, he may

find a basic idea in the system shown in Fig. 3. On the right is the primary system, with the secondary opposite. Each system consists of a casing containing a diaphragm. Pressure from either side of the orifice plate *B* act on leather diaphragm *C* through two gage pipes. The diaphragm transmits the difference of the pressures which act on it to jet pipe *A*. Differential pressure on orifice plate *E* operates correspondingly

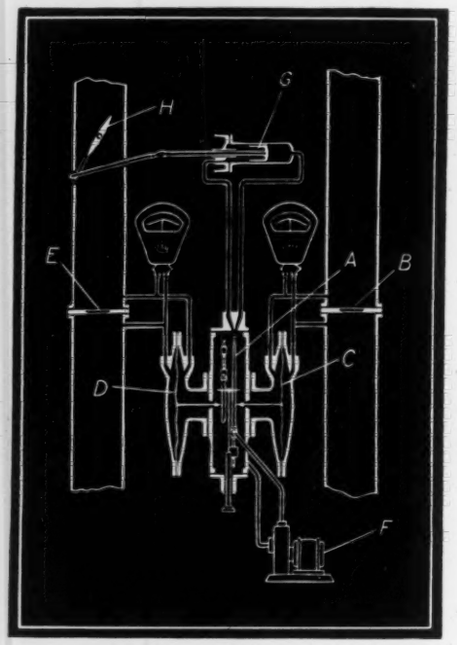


Fig. 3—Movement of jet pipe maintains ratio between pressure lines

on diaphragm *D* which transmits its differential pressure to the jet pipe.

The jet pipe is arranged to swing horizontally, and an operating liquid—usually oil at a pressure of 60 pounds per square inch—is introduced into it. Motor *F* pumps the oil. If the differential pressure increases at orifice plate *B* because of an increased flow of gas, the pressure transmitted from diaphragm *C* will become correspondingly stronger and will push the jet pipe to the left. As a result of this action the oil stream from the jet pipe strikes more and more on the left-hand orifice above the pipe. Obviously oil pressure increasing in the left-hand pipe, decreases in the right-hand. These changes in pressure actuate piston *G* in the regulating cylinder, the butterfly valve *H* will begin to open, and a ratio of volume of gas in the two lines will be maintained. The Askania unit was introduced by H. A. Brassert & Co., Chicago.

Welding in Hydrogen Atmosphere

PROMINENCE has been won recently by the copper hydrogen electric welding process. This is because it is new to industry generally although some of the country's large manufacturing plants have used it for some time. The Bundy Tubing Co., Detroit, recently installed one of the huge "zeppelin" type furnaces employed in the process.

The parts to be welded are assembled by a snug fit, either by inserting one part into the other or by spot welding or pinning the parts together. Copper either in the form of copper wire or copper paste is applied at the joint and the assemblies are loaded onto cars which are elevated automatically into the hydrogen-filled heating zone of the furnace. The parts are brought gradually to a maximum temperature of 2100 degrees Fahr., this alloying the copper with metal of the parts, bonding them together.

Simple changes in design to adapt the product to the hydrogen welding process often provide better appearance and effect increased strength and lighter weight. For instance a header for a multiple refrigeration installation assembled by this method from a length of tubing, stamped end-plate and screw machine fitting, takes the place of a whole network of copper tubing and brass fittings.

Absorbing Shock by Direct Action

ELIMINATION of lost motion being a fetish of engineers every effort is made where possible to effect a direct connection between parts. In mechanisms such as shock absorbers any tendency toward lost motion means sacrifice of riding comfort of the automobile. For that reason the Spicer Mfg. Co., Toledo, O., has designed a hydraulic unit, Fig. 4, that is mounted directly between the frame and the axle.

A chamber, surrounding the pressure cylinder, is filled partly with oil that serves as

Fig. 4—Shock absorber designed to be mounted directly between frame and axle

reserve supply, and partly with air which takes care of the piston rod displacement. The central working chamber is completely filled with a solid body of fluid. This type of design eliminates any side forces on the moving parts and the only points of internal leakage are past the piston and piston rod bushing. In both cases fits are easily controllable, the passage for fluid is relatively long and the area of the leakage passage small; it is not difficult therefore to obtain constant action. Lack of temperature variation in the unit even with a wide range

in oil viscosity is a result of the fact that the orifices which control the flow of fluid are extremely short compared to their area.

Visibility as a Sales Feature

PARTICULARLY in domestic machines is visibility a distinct asset. This, of course, also holds true in industrial units as in the case of the Pyralin press hood (Aug. p. 19) where the use of a transparent material aids the operator

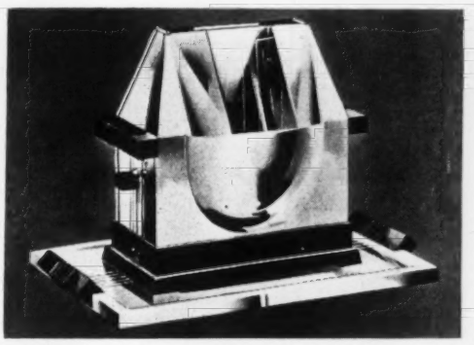


Fig. 5—Toaster exemplifies use of glass in design to impart visibility

in keeping a close check on the operation of the machine. The sales value of added visibility in household equipment is indicated by the Birtman electric toaster, Fig. 5, designed by Henry Dreyfuss, in which a glass window on either side enables the housewife to observe the toasting process. The chromium plated metal contrasts effectively with the black bakelite molded fitments.

In connection with the use of glass, it is interesting to note that the General Electric engineering laboratory regularly employs mirrors which weigh only about three one-millionths of an ounce, in an electromagnetic oscillograph. Each mirror is suspended between magnets by two wires. With each variation of voltage applied to the wires the mirror moves and traces these variations by means of a beam of light on a sensitive photographic film.

Speed Control with Vacuum Tubes

VACUUM tubes score again . . . this time in a new type of control for operating synchronous motors at variable speeds. The innovation is a development of Dr. E. F. W. Alexanderson who recently demonstrated it in the General Electric test laboratories. The electric ship is conceded to be one of the most important fields for this equipment. Because steam turbines operate most efficiently at full speed, the use of the vacuum tube control makes it unnecessary to slow them down when it is desired to cut down the speed of the propeller motors.

Equipment demonstrated included a 400-horsepower motor and 18 thyratron tubes, which converted the 4000 volts of power into different frequencies before it was delivered to the motor. This varying frequency in the current varied the speed of the motor. In changing the frequency of the current the tubes perform the function of a commutator. The grid control makes it possible to start with full torque from standstill and to operate the motor at any desired speed without wasting power in resistance. Furthermore, Dr. Alexanderson explains, the new apparatus facilitates remote control.

Copper Sheets Made by Electrolysis

THOSE engineers who specify sheet copper will be interested in developments in the production of thin metallic sheets by electrodeposition. Production, according to the American Brass Co., involves two steps, the first embodying electrolysis on a revolving cathode to make sheets up to 1 ounce thickness. Heavier sizes are produced by building up these sheets in a so-called loop cell. This copper sheeting may be bonded to other materials such as textiles, felt paper, fiber and composition board. Specially embossed and bonded to fabric by a flexible binder, 1½-ounce per square foot sheet is being used experimentally by automotive engineers as topping material for closed cars.

Mechanical Motions Create "Life"

ALTHOUGH principally a novelty, the mechanical figures of prehistoric men and beasts at A Century of Progress, also have an appeal from the standpoint of mechanical design. To make these figures lifelike, numerous ingenious movements, Fig. 6, are utilized. Constructed of steel, papier mache, sponge rubber

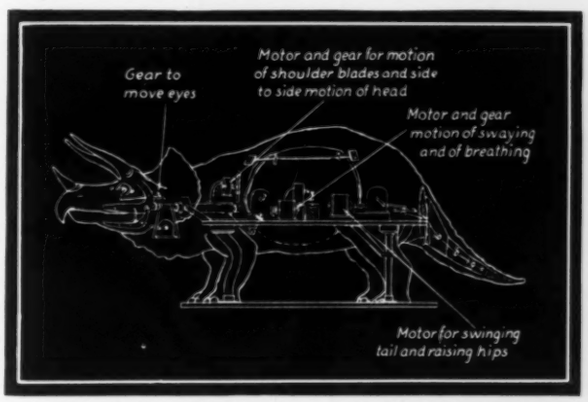

Gear to move eyes
Motor and gear for motion of shoulder blades and side to side motion of head
Motor and gear motion of swaying and of breathing
Motor for swinging tail and raising hips

Fig. 6—Far removed from a conventional machine, yet incorporating motors, gears and flexible shafts!

and wood, the figures incorporate gears, flexible shafts, counterweights and electric motors. In the 60-foot long amphibious Brontosaurus for instance, 18 motors are employed to provide hundreds of movements. The use of a Stephens-Adamson circular conveyor to carry spectators around the complete exhibit adds a modern touch.

Skillful Design Is Essential fo W

By J. L. Brown

THINGS that are new and different catch the popular fancy and enjoy a popularity which may be disproportionate to their real value or not well rated to it. On the other hand, a new product or method of exceptional merit, due largely perhaps to its popularity, often will suffer what seems to be a disproportionate amount of abuse through misapplication by its enthusiastic but not too well instructed friends. However, time brings the hard necessity for the demonstration of economic worth, and the fledgling product or method arriving at this period of testing is either determined to be economically unsound and cast aside or, being vindicated according to its just measure, passes into its period of maturity and enjoys an activity in direct proportion to its value.

Electric welding by the metallic arc has been practiced to a limited extent for many years, but the idea of utilizing this process as a major factor in the production of complete new structures is comparatively new. The process still is in that period of development in which its limitations are not well understood by those using it.

The mere use of the welding method of manufacture does not insure either a lower cost product, nor a product best suited for its function in either appearance or utility. In fact, perhaps even greater skill in design is required to produce low cost structures of good utility and appearance by the welding method than by some of the older methods of construction previously employed.

If a comparatively complex part is to be produced in any quantity, it is hopeless to expect a low cost product from the assembly of a multitude of small simple pieces fastened together by endless beads of weld metal. To achieve low cost in a welded structure, welding should be used sparingly. Right angle welded joints should be replaced wherever possible by the use of rolled steel sections giving the required right angle relation, Fig. 3. Rolling, bending and otherwise forming the steel parts used, as a means of reducing the necessary amount of welding, should be given careful consideration. The ideal structure will capitalize the efficiency of rolled steel shapes grouped together in an assembly of potential utility which may be realized practically by the application of a limited amount of welding in key positions and at critical points, Fig. 1.

To make a pleasing and inexpensive design

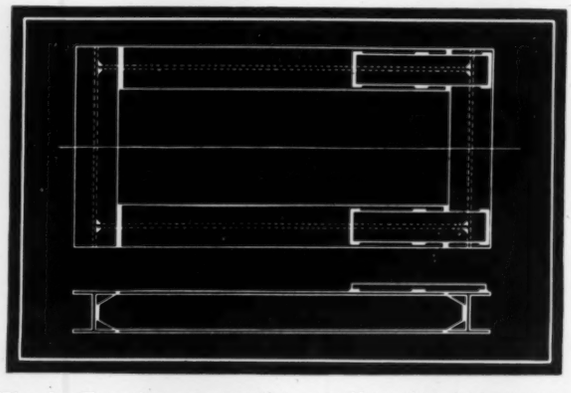


Fig. 2—Framing of members on H-section bed plates indicates method of fabricating

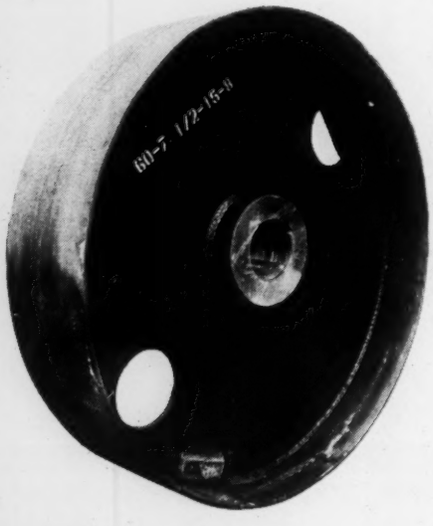


Fig. 1—Three distinctive steel shapes, united by welding, are used in this pulley

fo Welded Parts

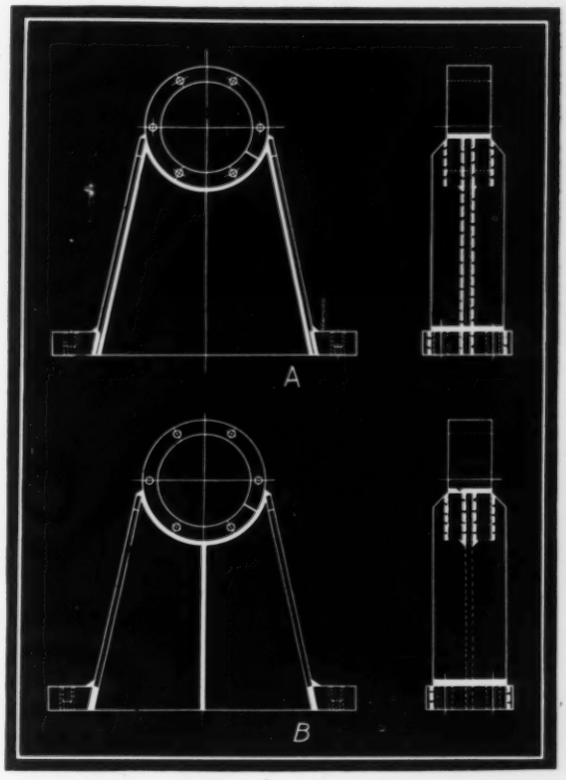


Fig. 3—Careful design reduced amount of welding considerably on this ball bearing pedestal. New design is at B

requires skill, and skill is acquired by experience—by intelligently doing the thing over and over again, analyzing time and material values and focusing the attention upon those features which tend to spoil the harmony of the assembled parts. A familiarity with the available steel shapes is essential—their forms, their relative strengths in bending and torsion, their cost per pound, available methods of cutting to size and similar points.

All other things being equal, economy will result from the use of constituent parts of the structure which are relatively easy to handle. For example, a part which can be handled by a man without the use of a crane or hoist of some kind will cost less to place in the assembly than a part too large or heavy for a man to handle unaided. Consideration must be given to the problem of placing and holding the parts in the proper assembly relation preparatory to welding, as time-consuming difficulty at this step in the fabrication may render an otherwise inexpensive product prohibitive in cost. Accessibility of the joints to be welded is important. Designs which require the turning over of the structure to give access to the joints to be welded will be more expensive than they would be if arranged to permit welding complete in one position.

WELDING, despite its value, is not necessarily the most economical production method, and as much or more care is required for design of parts to be produced by this process as by others. Some of the most important considerations to be taken into account when designing for welding are given by the author, of the Westinghouse Company's industrial motor engineering department.

Shrinking of the weld metal and adjacent heated parts when cooling introduces stresses which may distort the structure and require an expensive straightening operation or necessitate machining of surfaces which otherwise would be satisfactory without this added expense. Even though excessive distortion should not occur, the stresses introduced by cooling at the welds may be so great as to induce failure of the structure when the normal working stresses are added to them. These cooling stresses must be removed by annealing with consequent additional expense. Judicious placing of the welds will minimize or eliminate these difficulties.

In accomplishing these desirable economies in the fabrication of welded structures, only a limited number of steel shapes is available, and these often are not well adapted, seemingly, to the type of structure required. They were designed before electric welding was in vogue, and usually for far different purposes.

Redesign Should Be Simple

Machinery bases or bedplates appear to the casual observer as a simple type of structure. Surely, if it be desired to substitute a welded steel structure for the old design, this should be possible of accomplishment in the case of bedplates with a minimum of difficulty.

Experience leaves us with the definite con-

viction that one of the most outstanding facts about bedplates is the relative infrequency of duplicate designs. A study then of the problems encountered in the design of welded steel bedplates should be of practical value and be at least suggestive of the careful consideration necessary to produce efficient designs of more complex structures.

H-Sections Are Employed

One creditable form of bedplate employs four pieces of rolled steel H-sections having the ends formed and welded together as shown in Fig. 2. Such a bedplate holds the machines mounted upon it in proper assembled relation and provides a certain amount of rigidity. The problem of adjusting for disparity in center heights of machines and foot spread is taken care of by welding or otherwise attaching spacing pieces superimposed upon the bedplate proper. Its appearance is fair. The cost is apt to be high even though the number of inches of welding is not excessive. As the details which contribute to the cost are important to the designer, the more outstanding features will be outlined.

With average shop equipment, the most practical method of making the pieces of required length and form is the gas cutting torch. Before the cutting can be started, however, the lengths must be measured, squared and marked over every surface which the cutting flame must traverse. Extra expense is incurred also in beveling the ends of the flanges of the side beams to receive the weld metal deposited when making the joints. The final operation is removal of cinders adhering to the burned surfaces by means of a hammer and cold chisel. Thus, at the very threshhold of its manufacture, the advantages of the H-beam construction are offset to an appreciable extent in the tedious process of framing the parts to suitable form for assembly.

Must Bevel Flanges

In the commercial product the flanges of the H-beams are permitted a rather large out-of-square tolerance with respect to the web, rendering machining of upper and lower surfaces of the bedplate practically necessary. To retain proper attachment of the flanges at the corners after machining has been done, it is necessary to place the body of the weld below the surface. This requires beveling of the flanges of the side members as before described and a fifty per cent more expensive weld as compared with the fillet type used to make the joint between webs. Several turning-over operations necessitated by the positions of these welds delay the progress of the work and thus add to the cost.

Yet, as indicated at the outset, this form of bedplate has a number of creditable features. The number of inches of welding is limited, being confined to the corners. The section as rolled provides a surface in a plane suitable for mounting the machine feet, combined with a vertical member which gives "beam" strength to the structure, and "beam" strength combined with the torsional strength of the H-section results in a reasonable measure of rigidity of the bedplate as a whole. Distortion of the structure due to welding and subsequent cooling is avoided largely by confining the welding to the ends and edges of the members. Attachment to the supported machines and to the foundation is made readily through the medium of drilled and tapped holes conveniently placed in the beam flanges.

The problem of designing a bedplate to support a machine combination may be approached in a somewhat more logical manner, with the advantages of low cost and great simplicity, in adapting combinations of machines most dissimilar in shape and dimensions.

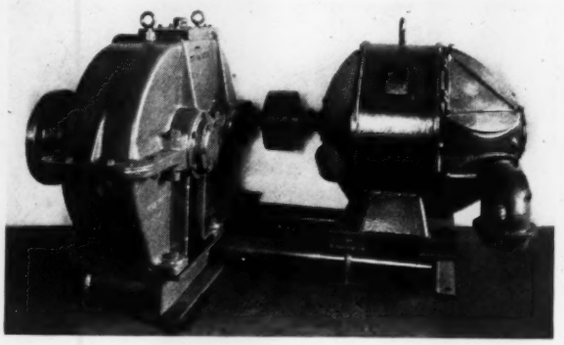


Fig. 4—Pipe and H-section type bedplate can accommodate irregular foot positions

Shafts Must Be in Line

The foot spread and center height of the two machines shown in Fig. 6 differ considerably. To operate these machines together by direct coupling requires that their shafts be in line as shown. Placing of lengths of available H or I-sections as shown in Fig. 6 readily solves the problem of dissimilar foot position, while longitudinal pipe members passing through the center H and I sections and welded to all four of them complete a bedplate structure of great economy, strength and simplicity. The amount of welding is small. The tendency to distortion is minimized by symmetrical placing of the welds. All welding may be completed without turning over the assembly, thus making it adaptable to welding in a fixture. All welds are of the most inexpensive, the fillet, type. The pipe members give maximum torsional strength, and thus bedplate rigidity for a minimum of weight. The flanges of the H and I-members

adapt the machine feet satisfactorily and provide adequate means for bolting to the foundation. From the standpoint of utility and cost this bedplate is ideal.

An example of the flexibility of the pipe and H section design is illustrated in Fig. 4. Not only are the foot spread and center heights of the motor and gear unit shown quite dissimilar, but the relative horizontal positions of the feet of the two machines are quite irregular.

Cost Is Reduced

In the pipe and H-section bedplate, cost and utility considerations have been taken care of successfully. Where the bedplate is completely grouted in, the form of the concrete pedestal in which the bedplate is set is the appearance presented to the observer, so that a form of bedplate which is pleasing to the eye becomes in such a case unimportant. However, not all structures are buried in concrete, not even all bedplates, so that in many, if not in most cases, obtaining a pleasing appearance is still a major problem. It must be admitted that the pipe and H-beam bedplate leaves something to be desired when appearance is considered. The unfavorable reaction toward it of those esthetically inclined arises from the dissimilarity in form of the various elements composing it. To achieve a structure of pleasing appearance, harmony of form of the various elements is a necessity. Fulfillment of this requirement without loss of cost and utility advantages hitherto gained renders the problem still more complex.

Fig. 5—Picture frame angle bedplate does not have to be moved during welding

Rectangle Generally Employed

Whatever the shape of the supported machinery, the plan view of the base usually is in the general form of a rectangle, a suitable transition to this form being effected in the elements attaching the feet to the machines themselves. It may be assumed, therefore, that if a rectangular foot plan has been incorporated pleasingly in the design of the supported machinery, the supporting bedplate in contact with these feet also may be rectangular in form without violating the elements of good taste. Rectangular!—not concave as in H-beams—not convex as in cylindrical pipes.

Profiting, then, by our experience with the types already discussed we may set down some of the desirable features for a newer design as follows:

Rectangular form for appearance

Flat surfaces for mounting the feet of the machines

Shearing, instead of burning, of the elements to length and form to avoid high cost

Welding at ends and edges only in symmetrical arrangement to avoid distortion

Welding without turning over of structure to avoid high cost

Tubular longitudinal members for torsional strength and rigidity

A "picture frame" angle-box with mitred corners gives the rectangular appearance and the flat surfaces to adapt the machine feet. The ends of the side and end members are sheared readily to length and form; welding is required at the ends only, and this can be done without turning the bedplate over. The side and end members are assembled with one leg laid on and clamped to a plane surface, consisting, at the mitred corners of the bedplate, of copper plates. The sheared edges are separated about 3/16 to 5/16 inch (depending upon thickness of the material) and butt welded with one pass of the electrode. The joint between vertical legs of the side and end angles may be welded from the outside in the vertical position.

Such a bedplate, however, is inherently lacking in rigidity. Sufficient rigidity may be obtained rather wastefully by greatly thickening the section of the angles or by welding in pipe members. As we still are interested in cost, however, a more efficient use of materials must be sought.

Rigidity Is Lacking

If a light and rather flimsy "picture-frame" angle box bedplate be modified by the addition of longitudinal members in the form of smaller, lighter angles welded inside the larger angles as in Fig. 7, this torsionally weak structure will be transformed into one of maximum rigidity—approximately twice that of an all H-section bedplate (such as shown in Fig. 2) of the same weight, by actual test.

Oftentimes complex problems are solved by simple means. In the last design mentioned just a few of one and only one of the simplest of rolled steel sections is required to fulfill the

various details enumerated in the three cardinal requirements for a satisfactory bedplate structure—appearance, utility and cost. And as often happens when one stumbles upon the correct solution of a problem, many unsought advantages appear, so in the tubular angle bedplate rather surprising results have been obtained which it had not occurred to us to seek.

Develop Internal Stresses

All hot rolled steel sections develop, in cooling, internal residual stresses which remain in the material (unless removed by annealing) even after put into service, and may be small or large, even approaching the elastic limit of the material. The tendency of these stresses to distortion of the material from its existing shape, and the maximum force acting to this end will be proportional to the inherent strength of the beam and will be opposed by the beam strength.

In the tubular angle bedplate shown in Fig. 7, each longitudinal member consists of two

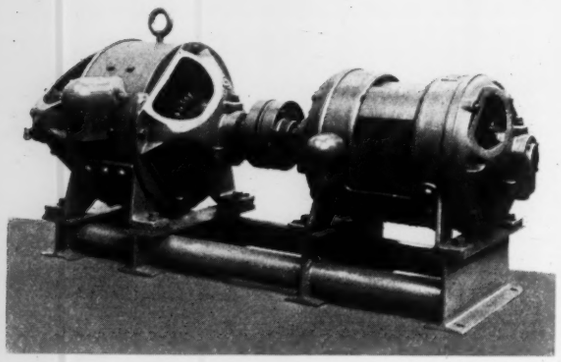


Fig. 6—Difficulties are encountered in coupling parts with dissimilar mounting requirements

angles opposed and welded together to form substantially a square tube or column. As compared with the strength of the resulting column, the strength of each individual angle is small.

Force Magnitude Small

The magnitude of internal force tending to distortion, being proportional, likewise will be small. Also, as the angles are assembled opposed, the internal forces of the two will probably also be opposed and thus tend to neutralize each other. The whole strength of the members of the tubular angle bedplate may, therefore, be available as working strength, instead of being devoted largely to resistance of internal forces tending to distortion.

Other advantages of the tubular angle bedplate might be mentioned. The object of this article is, however, not to show what is the best kind of bedplate for supporting machinery, but rather to use development in bedplate design as an example in bringing out as clearly as possible some of the considerations involved in achieving good appearance, maximum utility and low cost in welded structures in general. "Think before speaking" is a splendid motto. "Think before welding" is absolutely essential to economy and efficient use of that amazing modern tool of industry—the electric arc.

Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"When Should Welding Be Employed in Machine Design?" by Robert E. Kinkead, Sept., 1929, p. 14.

"How to Redesign a Machinery Base for Welded Construction," by E. H. Windle, March, 1930, p. 35.

"Winch Is Designed for Arc-Welded Construction," Oct., 1930, p. 35.

"Cost Factor To Be Considered in Welding," by Robert E. Kinkead, Nov., 1930, p. 44.

"Designing for Rapid Production of Spiral Welded Pipe," by Leon Cammen, April, 1931, p. 45, May, 1931, p. 43.

"Gas Cutting Alters Steel Structure," by L. M. Curtiss, Dec., 1931, p. 31.

"Combining Castings with Welded Structures," by J. G. Ritter, March, 1932, p. 40.

"Flexibility of Welding Combines Strength, Lightness," by Everett Chapman, May, 1932, p. 42.

"Stress Determination Is Imperative in Welding Design," by Robert E. Kinkead, Oct., 1932, p. 33.

"Complete Redesign Required for Welded Construction," by D. L. Pellett, Nov., 1932, p. 39.

"Economy of Torch Cut Parts Permits Refinement," by L. R. Tufts, Jan., 1933, p. 11.

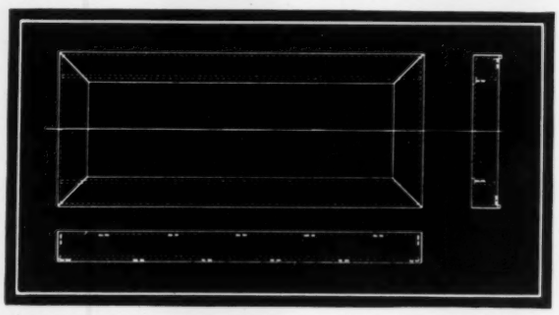


Fig. 7—Tubular angle bedplate has full strength of members employed for support

New Concept of Design Developed

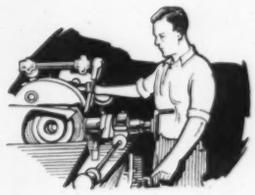
RECENTLY a new line of thought has developed in contemplation of the machine and its effect upon man. While not seeing in the machine the Frankenstein which is carrying the world to its doom, it is contended that the design of machinery has been accomplished to carry out a certain purpose without due regard for the physical characteristics of the individual who will operate it. The designer, being an engineer and not a student of anatomy, too often has failed to recognize in his product the fatigue-provoking elements inherent in its operation.—*Daily Metal Trade.*

Designer Should Specify Type of Machine Finish

By R. E. W. Harrison

PRODUCTION finishes on machine components should be specified clearly by the engineering department because the functional performance of the machine, especially if it is of the precision type, is either made or broken by the class of fits between mating spindles and bearings and between the housing and their slides. Quality of finish controls initial wear and, to a certain extent subsequent wear, as it determines the amount of clearance between the working members. Hence, it is of prime importance that the finishes be specified correctly, otherwise there is danger of the machine or mechanism suffering from premature old age.

Finish vitally affects salability and, whatever the purist may say to the contrary, no matter what the technical merit of a machine or mechanism may be it will not command a market unless it is well finished and finished so that it be pleasing to the customer.



These are two good and sufficient reasons why this vital question should be determined by the department most adequately equipped to decide. No one is in a better position to know and to specify the finish governing the quality of fits than the designing engineer, providing he has sufficient practical experience to enable him to apply his theoretical background correctly.

Checker Specifies Finish

One large manufacturer of machinery has found that a sound method of handling the matter is to have the quality of finish specified on the drawings by a well trained practical and theoretical engineer in the checking department. This man is so placed that he can consult frequently with the works and in turn draw on the practical experience of the works superintendent and in some cases the foremen, thereby making his decisions not only sound from an engineering viewpoint, but entirely acceptable from the production viewpoint, an important one.

Systematic finish control by the engineering department is not only practicable, but cheap to install. Furthermore, it provides the time study and production departments with an accurate basis on which to set time allowances and compute their costs of production.

Issue Adequate Instructions

Reference to this aspect of the subject, however, would not be complete without pointing out that with the installation of a system of finish control goes responsibility on the part of the production department of issuing adequate instructions to the operators, these instructions being based on previous practical and experimental methods which have been proved capable of producing the desired results.

For instance, in the grinding department it is necessary to specify the sequence of operations and the grits of the various grinding wheels which are to be used in building up the qualities of finishes exactly specified on the original development drawings.

Too much importance cannot be attached to this contribution which must be made by the production department, as otherwise useless discussion and endless arguments are generated and the whole matter is relegated once more to the realms of opinion, rather than being confined within the limits of a precise engineering control.

It is a "sine quo non" that almost any designer can design anything. However, there is a world of difference between an economically sound design and one which, while it is capable of performing the necessary functions, is expensive to make, unreliable and, somewhat unsal-

able after some service if not unsalable as soon as it has been used.

To reduce the subject to its simplest elements, the design of a machine is produced for one reason and that is to accomplish a given purpose. There are, however, two qualifying remarks which apply to this statement, these remarks being inseparable from the definition of an economically sound design.

The given purpose must be accomplished lastingly and the same purpose must be accomplished as economically as possible.

Taking the first of these, i.e., that the design must accomplish its purpose lastingly, we immediately encounter the question of finish of the machine's components. It is true that advances in the science of correct lubrication have made it possible for hitherto relatively imperfect mechanisms to enjoy a longer life, but the combination of correct lubrication with the correct finish on the wearing part will go a long way toward retarding the march of what might be termed "auto-destruction."

While it may be claimed by some economists that it is only right that machinery should be permitted to wear itself out in course of time, it is the writer's thought that the destroying factor in all machinery should invariably be economic obsolescence rather than mechanical failure.

The phrase stating that the given purpose of a design must be accomplished economically, also brings in the question of finish. It obviously is wasteful to specify a finish of a high grade when a low grade that costs considerably less to produce is suitable.

Time Is Opportune

The present most disturbed period is a particularly opportune time to consider this question because many manufacturing concerns are operating on a jobbing basis and there is a tendency to make all components to as high a degree of finish as is possible of attainment. This arises largely as a result of fear on the part of the operator that he may make some particular shaft diameter to a coarse finish, and then find he has jeopardized the performance of the piece or spoilt it by giving it a finish which renders it entirely unsuitable for its function, thus creating useless waste.

Coupled with this question of economics is "salability," inasmuch as to complete the economic cycle a mechanism not only must go together easily and last a long time, but it must sell easily, and one of the things which helps as much as anything in the sale of machinery is an attractive finish.

While most of the foregoing remarks have been of a somewhat abstract nature, they can be applied readily to any number of present day machines—the sewing machine, the domestic refrigerator, the automobile, and, last but not least, the airplane engine—all vitally affected by these questions. Particularly is this the case with the airplane engine where appearance is secondary and length of working life is vital.

If a small excursion into costs of operation is made, it will be found that each hour of useful flying service rendered by an airplane engine costs an appallingly high figure in depreciation, and if it is recognized that this high figure is the cost that the user pays for a skin of metal of an average thickness of not more than, say ten thousandths of an inch, some realization will be gained of the important function and valuable service which can be rendered by an up-to-the-minute engineering department in specifying qualities for this skin of ten thousandths of an inch which will insure that it yield a proper return on the amount of money—one might say almost the "enormous" amount of money—which is invested in it.

Turbine Evolution Depicted

BY MEANS of exact and actually functioning reproductions in miniature, twenty-one inventions, each an important forerunner to the development of modern electrical service, are attracting attention in the exhibit, "Electricity at Work," at the Century of Progress exposition. These tiny models serve as a fitting introduction to the extensive display which occupies the entire balcony floor of the electrical building.

The historic models present three lines of development. One series begins with Allessandro Volta's electric cell (1800) and ends with Thomas Edison's bipolar generator (1879). Two series show steam engine development. In one group are steam reciprocating engines, from Thomas Savery's pumping engine and boiler (1698) to George H. Corliss' engine (1849); in the other are models which trace the rotary type steam engine from a steam turbine built by Hero in 120 B. C. to De Laval's (1889) which was a feature of the Columbian World's fair.

The powerful modern turbo-generator traces its ancestry back to Savery's reciprocating engine, Hero's steam turbine and Volta's cell, for it was the convergence of these three lines of thought that made the turbo-generator possible.

Fig. 1—Each part may require a distinctly different material and large parts may have to be changed to several small ones for economy

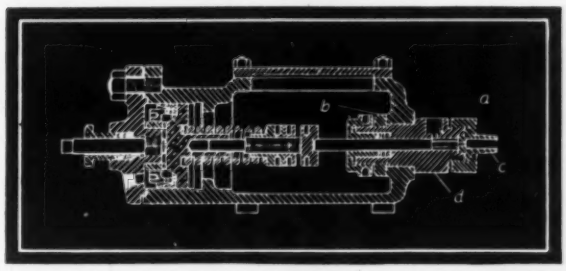
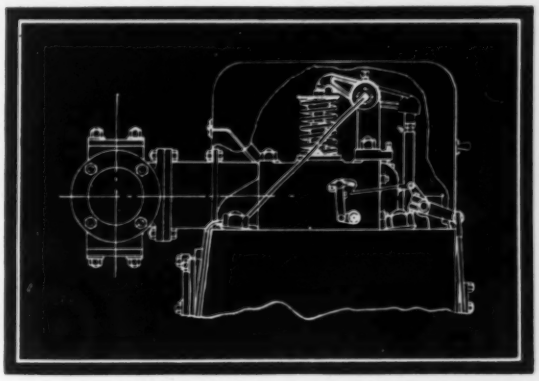


Fig. 2—Conventional materials proved to be the best for use for springs on this spring-returned system



Considering Design from the Production Standpoint

By Harold F. Shepherd

Part X—Materials

THE variety of materials now available to the designer puts a serious responsibility upon him. His selections no doubt will be recognized as final but they seemingly may be opposed to departmental viewpoints in which low cost, availability or machinability are first considerations.

Thus the designer of the union nut *a* Fig. 1 specified hot rolled steel of a moderately high carbon. With the high sulphur, free cutting, cold rolled bar available this seemed a serious error and would have been indictable except for the fact that the designer knew better than anyone in the organization that this nut would be removed and reset hundreds of times during the life of the apparatus. He had seen the threads on soft steel galled or welded together by the severity of this service, and had known the hexagon corners of plastic material to flow under the wrench until only a pipe wrench could be used. Hardening would have been desirable except for the impossibility of grinding the part internally to the required accuracy, and the material chosen was an economical compromise.

In the same apparatus, part *b* is made of the softer free machining steel. This part stays permanently in place and is subjected to no abrasion or wear. The same judgment that dictated the material at *a* was exercised here to save needless metal and machining costs.

The material in Fig. 1 at *c* is a high carbon chromium steel priced at approximately one dollar per pound. It is required to resist "wire drawing" due to high velocity flow of oil at 4000 to 5000 pounds pressure. Experience had shown that neither the material in *a* nor that in *b* was suitable for this purpose.

Originally, *a*, *c* and *d* had been one piece. The more involved design resulted from need of better material at the point of greatest wear coupled with the desirability of conducting only the simplest machining operations upon the most refractory material and of using the minimum quantity of the most expensive material.

Conservative Principles Best

Material selection again played an important part in design where the designer of a spring-returned system similar to Fig. 2 specified a material of remarkable properties in order to lighten the structure and reduce its dimensions and cost. He met with repeated but not systematic spring failure. He resorted to stroboscopic

methods seeking to find criticals that might be responsible for destructive amplitudes. He altered dimensions in various ways in order to change the natural frequency of the spring until convinced that vibration could not be responsible since failures persisted. He finally appealed to the spring makers. They advised him

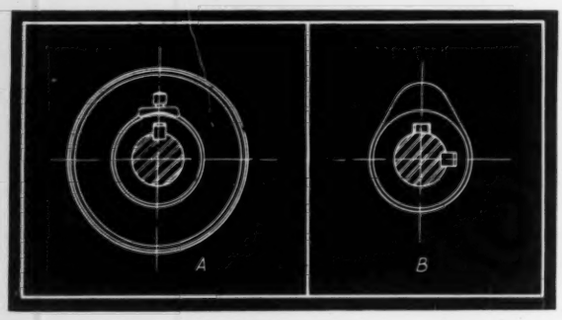


Fig. 3—A—Setscrew and key in shear for uniform torque only. B—One key in shear, one as wedge. Avoids four side fittings and precision indexing on key seater. Good for irregular and reversing torques

that the material chosen was exceedingly difficult to produce. The slightest mishap in processing might result in failure. He returned to conservative principles in design using conventional materials and experienced no more trouble.

However, all problems of materials in which designers and production men must collaborate are not to be solved on this assumption. It is well known that certain apparently frail structures resist great abuse by reason of their ability to yield before impact.

In some internal combustion engine starting systems a series motor with an armature of some considerable inertia moment is required intermittently to set up motion on a system of much greater WR^2. Ordinary steels failed repeatedly in the shafting of a special apparatus of this sort. Further increase of dimensions was impossible. Substitution of an oil-quenched and tempered chrome-nickel shaft of much smaller dimensions solved the problem. The need was not for lower but for higher working stress and a material capable of withstanding it. By large torsional deflection, impact through the gears was reduced or practically eliminated.

The spring principle of construction is, however, by no means a cure-all. In cases of critical speeds attended by destructive vibrations, relief often is sought by introducing alloy steel members of high physical properties. These may endure the total stress set up by static and dynamic loading somewhat longer, but they will not eliminate or much displace critical speeds.

The standard nickel steels and the chrome-nickel steels with perhaps some individual alloying with molybdenum or other elements usually are available in rounds for all machine purposes. Perhaps the list might be extended if the average production department were capable of heat treating the alloys properly, but so often it is not and many materials respond as positively to ill treatment as to good. Indirect pyrometry most often is at fault since the temperature at certain spots in a draughty furnace and that in the job may differ by as much or more than the allowable temperature limits.

Tempering Is Essential

Parts made of these materials generally should be forged and heat treated at the mill. In specifying heat treatment the designer never should be led into the common error of working for high tensile strength alone. Resistance to fatigue is usually sought and tempering is absolutely essential to this end. Most steels as employed in machine will stand drawing to as much as 1000 degrees Fahr., which vastly improves machinability.

This advice applies as well to those aluminum alloys that require aging in which case service working temperature should be stated to the maker. It applies also to the casting of all those "alloys" that are in part mechanical mixtures except white metal which we usually take the precaution of stirring regardless of mixture. The highly leaded brasses and bronzes require special handling in casting since the lead tends to liquate out and segregate into nodules. This

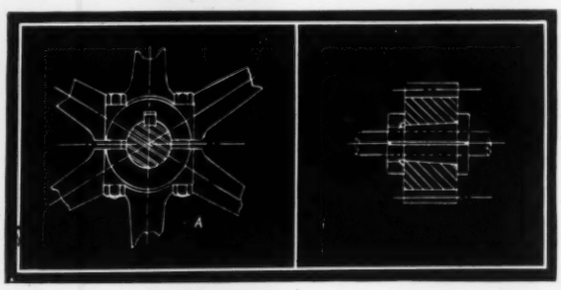


Fig. 4—A—Split hub and key, good anywhere, which is easy to assemble and dismantle. B—Self-centering split collet with or without keys increases seat area. Essential for ball bearings on commercial shafting

makes the metal difficult to finish and unsightly. Unless the founder is in on these "secrets" it is better to buy castings than pig metal.

Among other properties lost by hot working stock are those of heat treated bar. It seems almost unnecessary to point this out, yet heat treated chrome-vanadium flats have been bought for connecting rod straps and bent hot on the bulldozer with the innocent assumption that they retained the virtues imparted to them at the mill despite this further hot working.

Sheets are always cross rolled from bars.

Variations in finish are largely in annealing, blue or bright (box), in pickling, in rolling hot or cold and in leveling. Stretcher leveled sheets are a beautiful product but obviously it is a waste of effort and money to buy stretched sheets for electric or gas welding although they may be spot welded without serious distortion. Conversely the necessity of using leveled sheets for appearance may dictate the mode of fabrication. High carbon or alloy sheets are available by reason of their use for hardware and tools yet processing such as drawing or welding requires the use of low carbon sheets for most purposes.

Mentioned usually in connection with international standards of length, invar rod, which after all is 35 per cent nickel steel, has been used satisfactorily for studs in exhaust manifolds which were exposed to hot gases and tended to loosen when heated. An inquiry for a harder metal that possesses about the same coefficient of expansion as aluminum, or .000,0128 per degree Fahr., and one that may be secured to it without danger of expansion troubles brings out the fact that the iron alloy 18 Cr 8 Ni approximates this property. Its coefficient of expansion is .000,011. It may be used for long studs securing aluminum members which tend to crush under rising temperatures when confined by steel studs having a coefficient of .000,005,9. It has been used successfully for attachments to aluminum pistons.

Brass Has Advantages

A favorite expedient of the "new broom" is to go through a product and cut out all the brass. However, machining time on brass is about one-fourth that on mild steel. Its use as a material may evade much trouble and expense with tools, particularly small drills and small punches. Brass may be chosen also for its malleability and ductility in drawing, extrusion, swaging or press forging as in M. D., August.

Another factor in the specification of brass for a part, usually overlooked by the designer, can be illustrated by a machine detail that formerly was made in a machinery manufacturer's plant from brass rod. The part was turned down to about half diameter along three-quarters of its length, then this smaller portion had two flats machined on it. It was an expensive part, both from the standpoint of material and because production was not large enough to offset the set-up costs. An inquiry made of a job shop brought a quotation on this part that was almost exactly the same as the manufacturer was paying for the brass rod before any machining had been done on it. Investigation of this estimate revealed that the high resale value of brass scrap permitted the sale of the parts for little more than the cost of the original rod. Scrap values in brass are in fact so much more valuable than those in steel that it was for years the practice of makers of the small brass gears for clocks to sell the finished gears for just the cost of the original sheet from which they were blanked.

Manganese bronze may present a production problem that will make it desirable to turn to another material. This is especially true if a fairly deep hole must be made in the metal. Reaming of such a hole is not practical, as the metal is apt to heat up and grab the tool, thus preventing its withdrawal. A solution to this problem made on a part not required in large quantities was to prepare the hole by a drill operation and finish bore it. If it had been necessary, however, to supply these parts in large quantities, the best practice would have been to change to drop forgings, using steel with a carbon content of about 0.35 to obtain when treated approximately the same properties for the purpose as the manganese bronze.

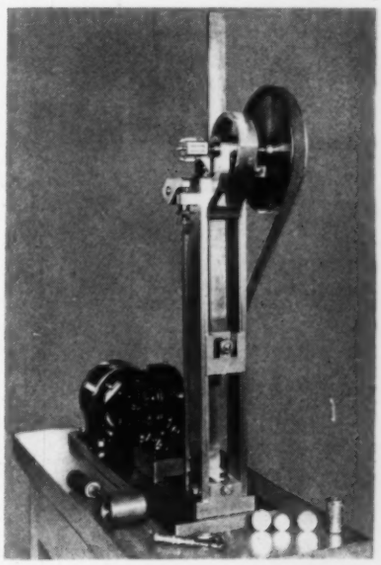


Fig. 5—Physical tests, such as impact tests on this machine, should be made if confirmation of claims for proprietary mixtures is needed

Tests Where Warranted

If the claims for proprietary mixtures warrant physical tests, they should be made. Specifications cannot be changed on faith. First of these is the impact test on 1 x ¼-inch machined samples under the miniature board drop hammer with 2½ pounds tup and 10-inch drop, Fig. 5. Each mixture has its optimum pouring temperature, also to be determined by impact tests.

It is impossible to force several parts mounted on straight commercial shafting successively without affecting the fit of the part last on and scoring journal surfaces. Consequently special limits are of little use. The desirability of using standard tolerances which are too coarse to permit assembly by force fits or shrinking calls for special consideration of every fastening. These measures are shown in Figs. 3 and 4.

Selecting Correct Alloys for Specific Uses

By Albert G. Zima

IN CHOOSING a steel for a certain application the engineer considers first of all the properties or performance desired. The size and shape of the piece determine to a great degree the composition and heat treatment to be employed in obtaining these results. Quite often the type of heat treating equipment available exerts an influence upon the selection of a steel. Finally, after these considerations there arises the problem of choosing the most economical steel for the purpose.

Typical nickel alloy steel castings, together with some of the uses to which they are applied successfully, are included in the table and discussed in the following. In some cases two or more steels may be mentioned as being suitable for a specific casting or class of service. This overlapping can be attributed to several causes. Some of the steels were developed by individual foundries, independent of one another, with the result that often two or more types are used for the same purpose. Again, certain steels possess unique properties which fit them best for certain uses, still they may be utilized safely for other purposes as well.

I—Low Carbon 2% Nickel Steel

This steel is recommended for parts subjected to shock and fatigue stresses. The retention of impact properties and ductility at low temperatures is another desirable characteristic, making it well adapted for castings used in cold climates.

Heat treatment. At 1750 degrees Fahr., 2 hours per inch of thickness, air cool; at 1500 to 1550 degrees Fahr., 1½ hours per inch of thickness, air cool; at 1100 to 1250 degrees Fahr., draw; cool in air or furnace.

Physical properties:

Yield point, lbs. per sq. in.	48,000-55,000
Tensile strength, lbs, per sq. in.	75,000-85,000
Elongation in 2 in., per cent	32-25
Reduction of area, per cent	65-45
Impact (Izod), ft.-lbs.	80-40

When given the full recommended heat treatment, the mechanical properties will approximate the maximum results while the lower values may be attained by means of a simple normalizing and drawing treatment.

II—Medium Carbon 2% Nickel Steel

This steel is well adapted for parts demanding higher strength and elastic properties than those given by the lower carbon steel previously discussed.

Heat Treatment. Normalized at 1650 degrees Fahr., drawn at 1200 degrees Fahr.

Physical properties:

Yield point, lbs. per sq. in.	57,000- 64,000
Tensile strength, lbs. per sq. in.	94,000-105,000
Elongation in 2 in., per cent	28-22
Reduction of area, per cent	55-42

III—Pearlitic Nickel-Manganese Steels

Manganese ordinarily is contained in cast steels in percentages from 0.50 to 0.80 per cent. In finished steel, amounts in excess of this may be considered to act as an alloy addition, imparting definite properties to the steel. They tend to increase the hardness and strength of the steel.

The pearlitic nickel-manganese steels are gaining recognition among the low alloy steel castings. They are often used to replace carbon and low alloy steel castings when the improvements desired in static and dynamic properties do not warrant the use of higher alloy steels.

Physical properties:

Yield point, lbs. per sq. in.	50,000-100,000
Tensile strength, lbs. per sq. in.	80,000-120,000
Elongation in 2 in., per cent	30-17

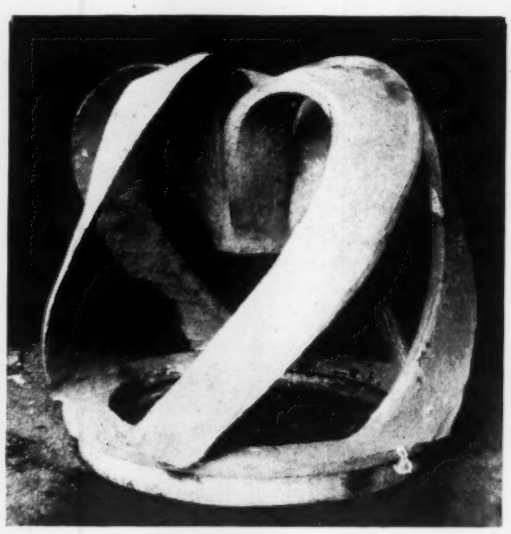


Fig. 1—Steel corresponding to type No. 9 is employed for dredge cutter blade

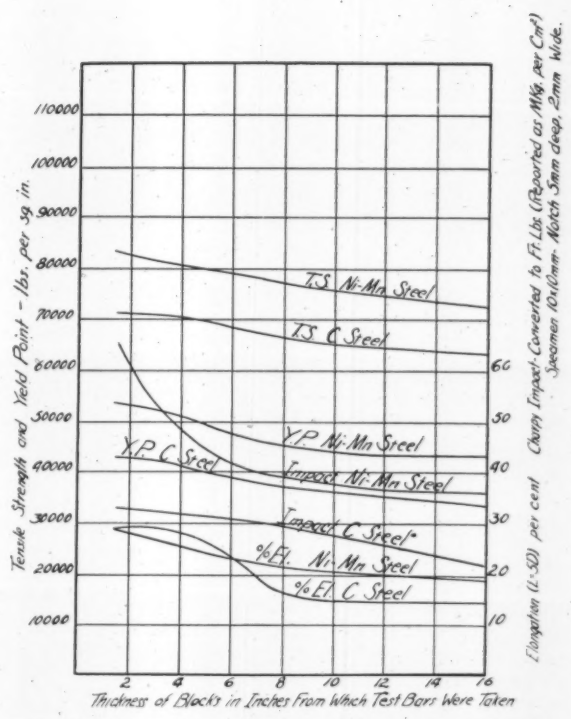

Tensile Strength and Yield Point - lbs. per sq. in.
Elongation (L=5D) per cent
Charpy Impact-Converted to Ft. Lbs. (Reported as M/kg. per Cm²) Specimen 10x10mm - Notch 5mm deep, 2mm Wide.
T.S. Ni-Mn Steel
T.S. C Steel
Y.P. Ni-Mn Steel
Y.P. C. Steel
Impact Ni-Mn Steel
Impact C Steel
% El. Ni-Mn Steel
% El. C Steel
Thickness of Blocks in Inches From Which Test Bars Were Taken

Fig. 2—Effect of section thickness on properties of carbon and pearlite nickel-manganese steel castings. Composition: Carbon steel—0.24 C, 0.40 Si, 0.77 Mn; nickel steel—0.22 C, 0.17 Si, 0.97 Mn, 0.96 Ni. Heat treatment: Carbon steel—normalized 1560 degrees Fahr., drawn 1100-1125 degrees Fahr.; nickel steel—normalized 1600 degrees Fahr., drawn 1100-1125 degrees Fahr. Specimens taken from centers of test blocks

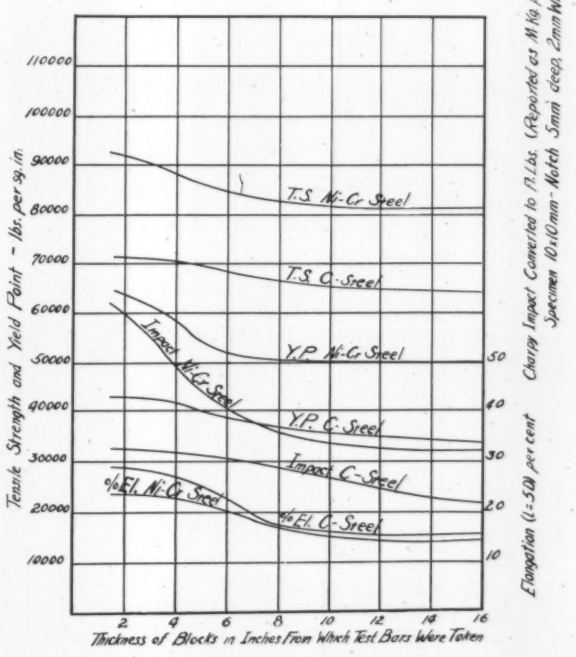

Tensile Strength and Yield Point - lbs. per sq. in.
Elongation (L=5D) per cent
Charpy Impact Converted to Ft. Lbs. (Reported as M Kg per Cm²) Specimen 10x10mm - Notch 5mm deep 2mm Wide.
T.S. Ni-Cr Steel
T.S. C-Steel
Y.P. Ni-Cr Steel
Impact Ni-Cr Steel
Y.P. C. Steel
Impact C-Steel
% El. Ni-Cr Steel
% El. C-Steel
Thickness of Blocks in Inches From Which Test Bars Were Taken

Fig. 3—Effect of section thickness on properties of carbon and nickel-chromium steel castings. Composition: Carbon steel—0.24 C, 0.40 Si, 0.77 Mn; nickel-chromium steel—0.19 C, 0.32 Si, 0.47 Mn, 2.01 Ni, 1.03 Cr. Heat treatment: Normalized 1600 degrees Fahr., drawn 110-1125 degrees Fahr. Specimens taken from centers of test blocks

SIZE and shape of the piece, conditions under which the machine will operate, heat treating equipment available, physical properties of the steel—all play an important part in the selection of an alloy for a specific machine part. Fortunately, as Mr. Zima of the International Nickel company's development and research department brings out in a paper presented before the Foundrymen's association, there is an alloy available for every type of application. Selection rests with the designer.

Reduction of area, per cent	55-34
Impact (Izod), ft. lbs.	44-20

Fig. 2 shows the influence of section upon the properties of a carbon steel and a nickel-manganese steel of approximately like carbon content.

IV—Nickel-Chromium Steels

Unlike nickel, which dissolves in the ferrite, chromium combines with the carbon in the steel, forming carbides of high strength and hardness. At the same time it tends to produce fineness of structure, thus increasing the static strength of the steel. Through the use of both nickel and chromium, steels may be produced possessing the desirable qualities inherent in each element. The ductility and toughness conferred by the nickel are combined with the strength and hardness imparted by the chromium.

These characteristics of the elements suggest that some ratio of nickel to chromium should be maintained to obtain the best combination of strength and ductility. Experience has shown that a nickel-chromium ratio of 2 or 2½ to 1 constitutes the best balance for the general run.

Fig. 3 illustrates the influence of section upon the properties of cast carbon and nickel-chromium steels.

The usual heat treatment for this type of steel is: Full annealed at 1700 degrees Fahr.; air cooled from 1650 degrees Fahr.; drawn at 1250 degrees Fahr.

Physical properties of normalized and drawn nickel-chromium steels:

Yield point, lbs. per sq. in.	60-000- 69,000
Tensile strength, lbs. per sq. in.	95,000-110,000
Elongation in 2 in., per cent	23-18
Reduction of area, per cent	45-36
Impact (Izod) ft. lbs.	41-26

The proportions of nickel and chromium in these steels are so balanced that quenching in oil and tempering emphasizes and strengthening and hardening effects of these elements with maintenance of a high degree of ductility. The retarding effects of nickel and chromium upon the critical cooling rate facilitates hardness penetration on quenching, thus insuring a de-

gree of uniformity of properties throughout the section not obtainable in shallow hardening steels.

Some nickel-chromium steels exhibit low impact values after slow cooling to room temperature from a high tempering temperature (950 to 1250 degrees Fahr.). This effect, termed "temper brittleness," is not revealed by tensile tests but by the notch toughness of the steel; it usually can be avoided by cooling rapidly from the tempering temperature.

V—Nickel-Vanadium Steels

Vanadium steel castings rarely contain more than 0.15 to 0.25 per cent vanadium. Steel castings containing 0.10 to 0.15 per cent vanadium, and 1.50 to 2.50 per cent nickel, exhibit high strength and elastic limit together with good ductility.

Physical properties:

Yield point, lbs. per sq. in.	85,000-87,000
Tensile strength, lbs. per sq. in.	55,000-70,000
Elongation in 2 in. per cent	30-25
Reduction in area, per cent	60-50
Impact (Izod) ft. lbs.	63-47

VI—Nickel-Molybdenum and Nickel-Chromium-Molybdenum Steels

In order to obtain the full benefits from molybdenum it generally is necessary that it be supplemented by some other alloy such as nickel or chromium, or a combination of nickel and chromium. The nickel-molybdenum and nickel-chromium-molybdenum steels are giving a good account of themselves in castings where high strength and high elastic properties combined with excellent ductility are required. They lend themselves readily to air quenching treatments and are particularly adapted to the production of large castings.

Also, their ability to retain high strength at elevated temperatures extends their field of usefulness to many industrial applications where heat is involved. They are not difficult to produce, as neither nickel nor molybdenum are oxidized in the bath under normal conditions.

Although the cast nickel-molybdenum steels have not been produced extensively, they have been used successfully for certain highly stressed parts and other castings subjected to severe loads. A cast nickel-molybdenum steel containing 0.35 to 0.45 carbon, 0.60 to 0.80 manganese, 0.20 to 0.40 silicon, 0.50 to 1.00 nickel, and 0.20 to 0.30 molybdenum, is used for gears and pinions for steel mill machinery. They are annealed, machined and then heat treated to a brinell hardness of 380 to 495, depending upon the application. In this condition, these castings possess good wear and shock resistant properties.

Physical properties of nickel-molybdenum steels:

Yield point, lbs. per sq. in.	59,000-62,000
Tensile strength, lbs. per sq. in.	86,000-96,000
Elongation in 2 in. per cent	27-23
Reduction in area, per cent	61-51

The wide range of properties obtainable through variations in heat treatment adapt cast nickel-chromium-molybdenum steels to many types of service. For example, when annealed such steel is suitable for many structural castings demanding high strength and good ductility. When normalized and drawn, it may be used for tractor shoes, sheaves, sprockets, etc.

Physical properties of nickel-molybdenum chromium steels:

Yield point, lbs. per sq. in.	65,000-141,000
Tensile strength, lbs. per sq. in.	106,000-155,000
Elongation in 2 in., per cent	20-13
Reduction of area, per cent	38-25

The retention of hardness and strength even after exposure to temperatures up to 1000 degrees Fahr. makes this steel especially useful for castings operating at moderately elevated temperatures. This steel also is used extensively for abrasion-resistant castings.

VII—Abrasion-Resistant Castings

For a number of applications requiring resistance to abrasion only, chilled cast iron, high carbon steel or the plain chromium steels are often adequate; but where shock and fatigue stresses are encountered as well, the nickel alloy steels are superior. The major portion of the alloy steel tonnage devoted to this difficult service is made up of the heat treated nickel-chromium and nickel-chromium-molybdenum steels.

A low temperature tempering treatment (600 to 800 degrees Fahr.) minimizes the stresses which are set up on rapid cooling and does not lower the hardness appreciably. In this condition this steel is suitable for applications not requiring high impact resistance or toughness.

These castings usually are air quenched from about 1550 degrees Fahr. after annealing to 1650 to 1750 degrees Fahr., and then drawn at 700 to 800 degrees Fahr. for at least two hours per inch of thickness. Castings 4 to 6 inches in thickness, when heat treated in this manner, acquire a hardness of 380 to 450 brinell through-

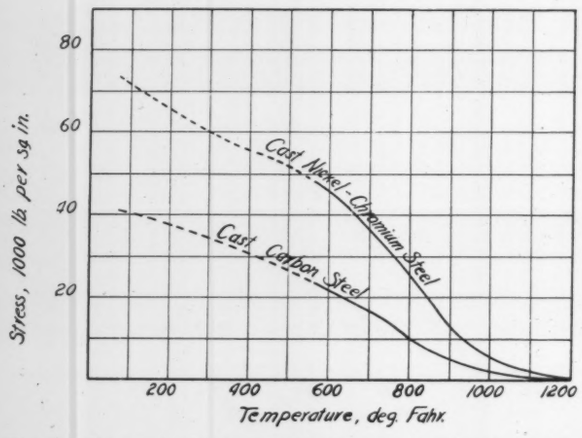


Fig. 4—Comparison of creep limit stresses of cast carbon steel and cast nickel-chromium steel

TABLE I

Typical Applications of Cast Nickel Alloy Steel

Requirements	Typical Applications	Type Composition of Steel	Section
HIGHLY DUCTILE STEELS RESISTANT TO SHOCK AND FATIGUE AT ATMOSPHERIC AND LOW TEMPERATURES	Locomotive frames, castings for mining, excavating and steel mill machinery, ship castings	Low-Carbon 2% Nickel C .20 max.; Ni 2.00 min.; Mn .60-.90; Si .15 min.; P and S under .05	I
With somewhat higher carbon increased elastic properties and strength can be obtained.	Miscellanoeus railroad castings, large gears not subjected to severe abrasion, crusher, tractor and power shovel frames	Medium-Carbon 2% Nickel C .20-.30; Ni 2.00-2.25; Mn .80-1.00; Si .15 min.; P and S under .05	II
MODERATE COST WITH STRENGTH AND DUCTILITY SUPERIOR TO CARBON STEELS. These steels characterized by uniform properties. They are easily machined.	Various castings for tractors, trucks, road building machinery, and other highly stressed parts. Has been used for electrical machinery castings up to 6-inch thickness	Pearlitic Nickel-Manganese C .20-.40; Ni .75-2.00; Mn 1.00-1.50 Usual composition: C .25-.35; Ni 1.00 min.; Mn 1.00 (1.20 max.)	III
SUPERIOR MECHANICAL PROPERTIES IN NORMALIZED CASTINGS. For Light and Medium Sections.	Oil-well tools, sheaves, sprockets, tractor shoes, gears, cams	Nickel-Chromium C .30-.40; Ni 1.25-1.50; Cr. .70-.90; Mn .60-.90	IV
		Nickel-Molybdenum C .30-.40; Ni 1.25-1.50; Mo .20-.30; Mn .60-.90	VI
For Medium and Heavy Sections.	Miscellaneous castings for locomotives, rolling mill machinery, highly stressed gears and machinery subjected to rugged service.	Nickel-Chromium-Molybdenum C .30-.40; Ni 1.50-2.00; Cr .70-.90; Mo .20-.40; Mn .60-.90	VI
		Nickel-Molybdenum	IV
		Nickel-Vanadium C .25-.35; Ni 1.25-1.75; V .08-.15; Mn .60-.90	V
QUENCHED AND TEMPERED STEEL CASTINGS WITH HIGH STRENGTH, HARDNESS AND WEAR RESISTANCE. For Light and Medium Sections.	Hardened gears, cams, rollers, sprockets, conveyor-chain links, etc., oil well tools, sheaves. These castings are sometimes differentially hardened	Nickel-Chromium C .35-.50; Ni 1.25-1.75; Cr .60-.90; Mn .60-.80	IV
		Nickel-Chromium-Molybdenum C .25-.35; Ni 1.75-2.25; Cr .60-.90; Mo .15-.25; Mn .60-.80	VI
For Medium and Heavy Sections.	Highly stressed gears, pinions, racks, rollers, sprockets and miscellaneous parts of medium and heavy section	Nickel-Chromium-Molybdenum	VI
		Nickel-Chromium C .35-.50; Ni 2.00-2.75; Cr .75-1.00; Mn .60-.80	IV
ABRASION RESISTANT CASTINGS. For Light and Medium Sections.	Particularly adapted for castings which are to be differentially hardened; for example, power shovel teeth, impact hammers	Nickel-Chromium Nickel-Chromium-Molybdenum	VII
	Ball and tube-mill liner plates, ore chute liners and other parts not subjected to high impact	Nickel-Chromium-Moleybdnum C .50-.60; Ni 1.50-2.00; Cr .60-.90; Mo .30-.50; Mn .60-.80	VII
For Medium and Heavy Sections.	Crusher jaws, dredge pumps, impact hammers, etc.	Nickel-Chromium-Molybdenum C .40-.60; Ni 3.00-3.50; Cr 1.00-1.25; Mo .30-.50; Mn .60-.80	VII
Resistance to abrasion under heavy pressure and impact. Retention of ductility after exposure to temperatures up to 1100 degrees F. Weldability. For Light, Medium or Heavy Sections.	Hot bed run-out tables, forming dies for lap-welded pipe, draw bench chain for butt-welded tube mills, heavy crusher rolls, jaws and liners, railroad crossings	Austenitic Nickel-Manganese C .60-.80; Ni 3.00-5.00; Mn 10.0-15.0	VIII
STRENGTH AND "CREEP" RESISTANCE AT ELEVATED TEMPERATURES.	Valves and fittings, return bends, superheater and heat exchanger heads, cement clinker chain	Nickel-Chromium C .30-.40; Ni 1.75-2.25; Cr .70-.90; Mn .60-.80 Nickel-Chromium-Molybdenum with carbon .30-.40	IX

out. Usually such castings are rough machined in the annealed state and then ground to finish after hardening.

When given this treatment but drawn at 1200 to 1250 degrees Fahr., this steel is well suited for parts which are called upon to resist high stresses and abrasion.

VIII—Austenitic Nickel-Manganese Steel

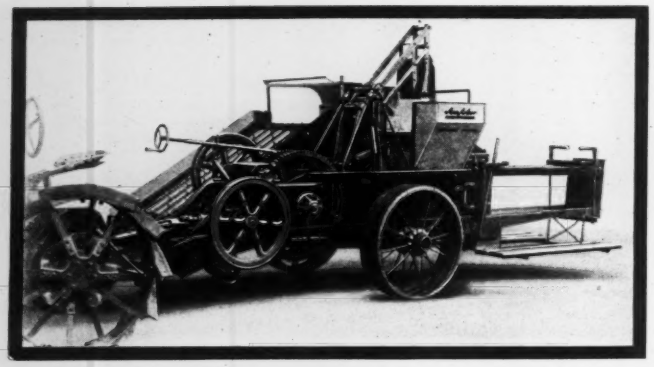
Austenitic or high manganese steel of the Hadfield type is well known as an abrasion-resistant material, but this quality is not exhibited unless the steel is subjected to cold working either before or during service. There are also other factors which limit the use of ordinary Hadfield manganese steel. In order to bring about the austenitic structure required to maintain the toughness of this steel, the castings are heated to 1800 degrees Fahr. or higher and quenched in cold water. This steel possesses a high coefficient of thermal expansion and a low heat conductivity, a combination of properties which reacts adversely in the quenching of heavy sections. Castings exceeding 5 or 6 inch thickness cannot be quenched without producing internal cracks which often cause failure in service.

Moreover, if heat treated manganese steel castings are reheated to 600 to 800 degrees Fahr., the dissolved carbides are reprecipitated, thus bringing about extreme brittleness. This phenomenon precludes the use of this steel for service at elevated temperatures and makes welding or forging exceedingly difficult.

Alloy Retains Its Strength

To overcome these difficulties and to extend the field of usefulness of this steel, a modified composition wherein 3 to 5 per cent nickel is added has been developed. This steel, after a simple normalizing treatment, exhibits the same characteristic toughness and work hardening properties as ordinary Hadfield manganese steel. Moreover, it retains its strength and toughness even after long exposure to temperatures up to 800 degrees Fahr. or short exposure at 1100 degrees Fahr. Large wear resistant cast-

(*Concluded on Page* 60)



Several harvesting operations are combined into one by new agricultural machine

Varying Conditions Test Agricultural Machinery Design

By L. R. Tallman

WITH the increasing interest of farmers in the raising of legumes, particularly alfalfa, came the call for an agricultural machine that would combine two or more harvesting operations into one and at the same time prepare the crop for market with a proportionate saving in labor and costs. One problem that had to be solved in its design is that a vast percentage of farmers refuse to waste their straw. This proved the deciding factor as to the justification of the time, effort and expenditure that would be involved in the pioneering of an entirely new type of agricultural machine that would pick up forage crops automatically from the windrow and prepare them for market in one operation, for in the salvaging of this straw it is only necessary to disconnect the drive to the straw spreader of the grain combine to permit the straw to be dropped on the stubble in perfect windrows.

Maximum Capacity Needed

In developing a successful pick up baler, it is highly essential that the baling press unit possess the maximum in capacity and strength with minimum weight. It must be free of mechanisms which tend to produce vibration or throw it out of balance in operation. It should partially balance on a single axle with the forward end resting on the draw bar of the tractor in order to provide the shortest possible turning radius as well as to allow the pick up unit to follow closely the contour of the ground. The frame which serves as the foundation of the entire machine must be trussed amply to guard against sagging as a result of the extra duties imposed upon it as a traveling field machine.

Weight at a Minimum

Even though the pick up baler has an advantage over other types of traveling field machines in that it ordinarily is operated on comparatively solid hay meadows, the problem of keeping total weight to a minimum is of utmost importance. Power must be provided for operating the machine either by means of a separate engine, or it must be transmitted from the tractor. A separate engine adds weight, cost, fuel consumption, maintenance and depreciation. As only eight horsepower is required for operating the machine, the rear power take-off facilities now provided on tractors were wholly adequate for the job.

The balancing point of the conventional belt power baler being so far forward of the center of the frame presents somewhat of a problem in mounting on a single axle, especially in view of the fact that additional weight must be added

still ahead in order to provide the means of transmitting power from the power takeoff. This problem was solved to a great extent by eliminating the belt shaft of the baling press, adhering to the same gear centers and attaching the drive pinion to one end of the cross shaft of the power take-off transmission and the balance wheel to the other, and at the same time eliminating the necessity for belts and pulleys. In addition to the important reduction of weight and number of parts as a result of this unique feature, the only shafts on the machine revolving at a speed greater than 220 revolutions per minute are carried on roller bearings for greater effiiciency.

In order to keep angularity of the universal joints of the drive shaft to a minimum, the height of the power take-off transmission was designed in keeping with the average height of the power take-off outlets of the various tractors. The angularity of the universal joints is practically fixed on a two-wheel machine except in turning, whereas with a four-wheel machine it would at times be excessive in operation over uneven ground. A problem of no small consequence was that of providing a force feeding unit on which depended the success or failure of the machine as an automatic machine that would require no manual assistance except for the simple operation of wiring the bales.

THE designer developing a machine to fill packages of identical size, to form steel, or to do any of the many operations the general run of industrial machines will perform, does not realize the limitations that are placed on design by the numerous variables encountered in the operation of agricultural machinery. Real ingenuity in design is required in this field as Mr. Tallman, general manager, Ann Arbor Machine Co., brings out in this article abstracted from a paper presented before the Agricultural Engineering society.

This unit must be equally efficient in working either forward or backward, and on it depends the quick separation of the hay stream for dropping the divider block as well as the positive starting of the hay again after the block is in place. Tines 5 inches long literally reach out and pull the hay or straw in from above, semi-compress it as it passes into the hopper of the baler so that it will be kept well under the bottom of the feeder head and then strip straight out.

Drive Experiments Necessary

Whether the pick-up should be ground driven or power driven was another important decision. Early experiments were mainly confined to the ground drive off the right transport wheel and through a countershaft necessitating additional sprockets and other parts, together with several extra feet of drive chain. The idea was to recommend the removal of the combined pick-up and elevating conveyor unit for stationary baling (which can be accomplished by the removal of three bolts or pins), and pitch directly into the cross feed unit.

Capacity Is Increased

It was soon discovered that the rather unusually large area of the elevating conveyor offered outstanding advantages for receiving the hay or straw pitched or merely shoved on to it from stacks. In feeding from near the ground with the pick-up power driven it is only necessary to push the hay or straw against or over the end of the pick-up cylinder. The adoption of the power drive added to the capacity of the machine in stationary baling and entirely eliminated the need for at least one man. Side draft was also eliminated by relieving the transport wheel of the added rolling resistance involved in driving the pick-up. This importance is further emphasized by the essential location of the right transport wheel being some distance from the line of draft. An added advantage is gained in "gearing down" through the power drive instead of "gearing up" as is necessary whenever power is taken from the transport wheel.

Safety Clutches Provided

Safety clutches are provided at all three points of power delivery which insure against sufficient power being applied to spring or break any parts. A condition which might arise where safety clutches would be of inestimable value is where a small piece of wood would become wedged in the pick-up. An over-running clutch also is built into the power shaft connecting the drive from the tractor to guard against the momentum of the balance wheel of the baler unit transmitting power through the tractor on closing the throttle.

One and one-eight inch shafting is used throughout the entire machine, exclusive of the baling press unit. These shafts operate at speeds of from 35 revolutions per minute to a maximum of 165 revolutions per minute making it possible for all 15 cast iron self-aligning bearings to be interchangeable, a vital necessity in farm machinery.

MACHINE DESIGN

L. E. JERMY, EDITOR
ALLEN F. CLARK
HAROLD B. VEITH
F. H. BURGESS

Progress in Design Is Dependent on Advances in Materials

IF IT were possible to assemble in one place all of the new and improved machines introduced during the past five years, we would be amazed at the extent to which the improvements reflect the influence of new materials.

No such overall view of recent progress in machine design is obtainable. Fortunately, however, an approach to it is afforded by the various industrial exhibits at the Century of Progress Exposition. There may be seen lighter cars and locomotives, speedier airplanes, improved automobiles and power boats, more efficient refrigerators and other items of household equipment, industrial machinery in great variety and hundreds of parts and appliances which are employed in machine construction. Almost without exception, these exhibits of the latest developments in the field of machinery pay tribute to the availability of a broader range of appropriate materials than previously has been placed at the command of machine designers.

In view of this notable evidence of the present ascendency of materials, the "Directory of Iron, Steel and Nonferrous Alloys," issued as a supplement to this issue of MACHINE DESIGN, is a timely publication. In its third edition, it embraces many new alloys of recent development and is of broader scope than the earlier editions.

Today individuals indentified with the design of machines should be more familiar than ever before with the properties of alloys. More and more, outstanding achievements in design will depend upon selecting the proper material for each specific requirement.

• • •

Meeting the Customer

ABILITY to meet customer requirements being the primary factor in determining the success or failure of a machine, intensive investigation of the field is becoming more desirable with changing conditions and needs. It is not difficult to recall numerous cases in which manufacturers in the past have wasted thousands of dollars in development of new machines, relying solely on the judgment of an individual or on the visualization of a market that actually did not exist.

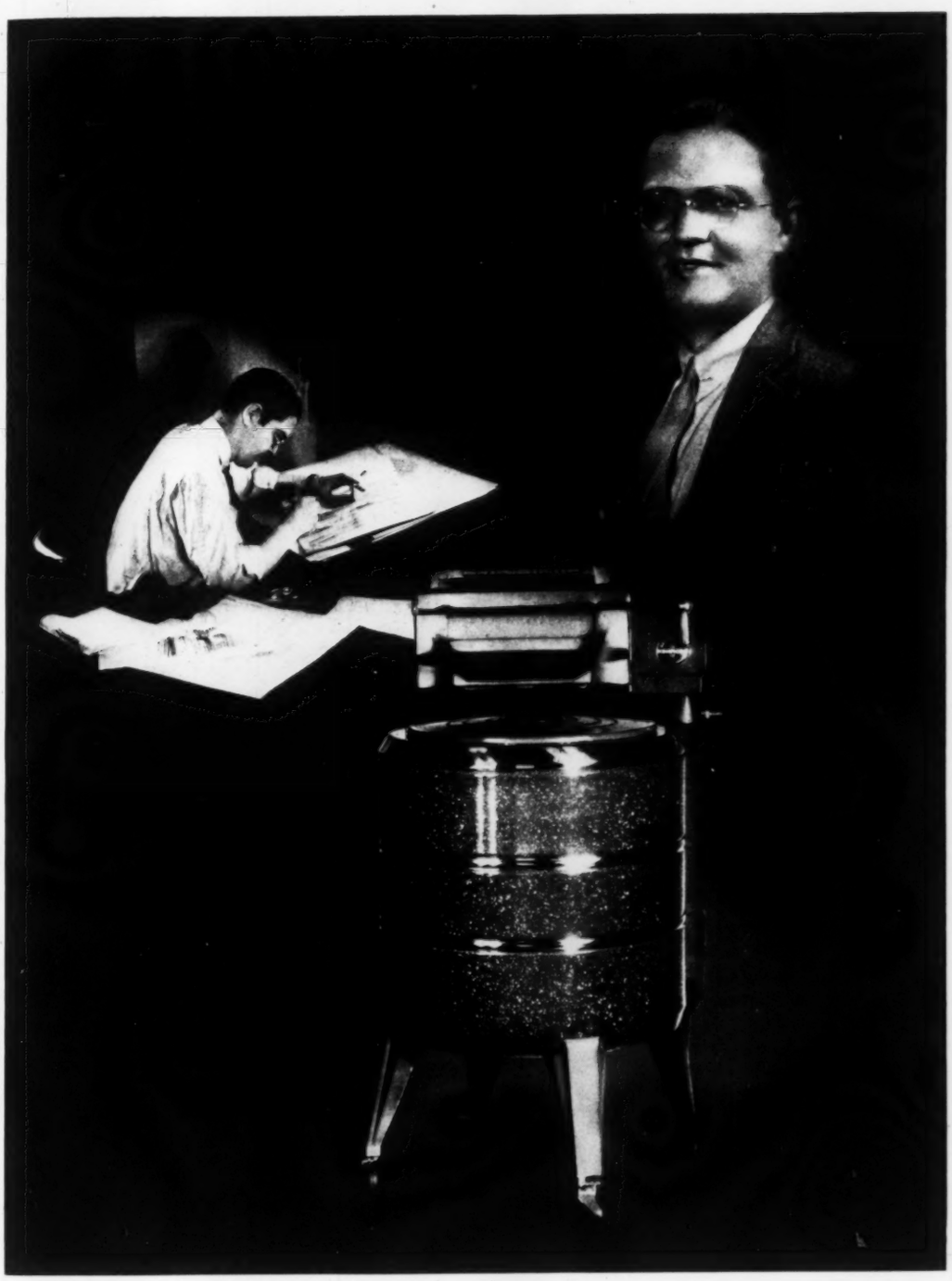
A thorough-going example of customer research is obtainable from the method being followed at the present time by one of the leading automobile companies. Questionnaire booklets are being mailed to over a million potential users. A costly process, but one that cannot fail to bring results.

Few instances of market research compare with this. It is an outstanding example of the present-day need for investigating changing market conditions and trends.

MEN

and Their

MACHINES



HENRY DREYFUSS AND HIS WASHING MACHINE

Men and Their Machines

Domestic Equipment

THE name Henry Dreyfuss is symbolical of design. His work in this direction virtually knows no bounds. He does not confine himself to specialization in mechanical design but spreads his activity over a wide variety of projects. This brings him a freshness of viewpoint, and a rounded experience. Such is necessary in industrial design where an individual may be retained by numerous companies as in the case of Mr. Dreyfuss. Surely this is indicative of the importance of observation in other fields as a stimulant of design ideas.

One of the more recent machines with which Mr. Dreyfuss' name has been identified is the Kenmore washing machine which he created for Sears, Roebuck & Co. He produced a distinctive unit for a low-price market after careful study of existing machines, production facilities and plant processes. Featuring the washer is the toperator which embodies centralization of all controls at the top of the machine. This he worked out in close collaboration with Sears engineers.

Many large engineering companies retain him as a consultant in industrial design. The theatre also has been his workshop, the settings of some of the recent big hits of the stage being designed by him. His versatility is even more apparent when it is recalled that he completely designed two of the latest R.K.O. theatres.

From his broad perspective Dreyfuss some years ago visualized an unusual opportunity for improving the appearance of industrial machinery. His mechanical bent asserted itself in the ability to design machines that fit into specific mass production schedules. Sales appeal, which as many engineers realize, is one of the ultimate objectives in design, never is lost sight of by him. He does not place himself in the position of an engineer, but rather has proved that he is capable of arousing the complete respect and co-operation of manufacturers' staffs in carrying out his ideas.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Welcomes Letters or Solutions to Problems Suitable for Publication

Employ a Piece Rate System?

To the Editor:

WE HAVE had considerable discussion recently in our company as to whether or not it is practical to install some form of piece rate system in a design department.

I have been keeping a record of the time required to detail various classes of drawings, and it seems to me it would be a comparatively easy matter to establish a piece rate on this class of work. It also might be possible to establish a piece rate on the more simple design jobs, as we find we can estimate fairly accurately the time required to turn these jobs out.

I am very much interested to know whether or not you or your readers know of any engineering departments that have successfully used this method of paying for the work done. Everything else in our factory is on a piece rate system and has shown large savings and increased efficiency over the previous hourly rates.

If this system, with some modifications, could be employed successfully in an engineering department, I am sure that not only would efficiency be increased greatly, but our better men could secure greater earnings.

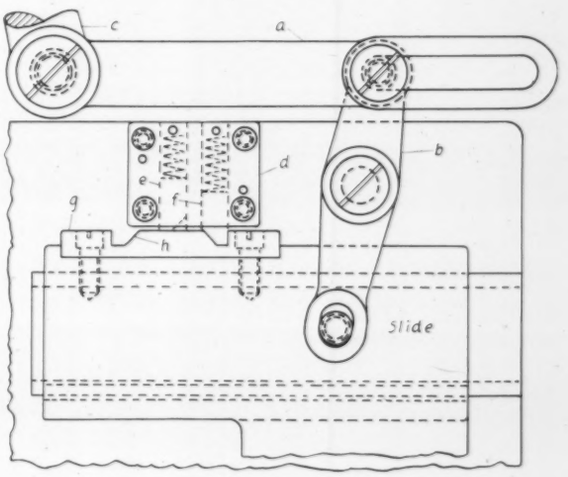
—CHIEF ENGINEER

EDITOR'S NOTE: There is much doubt as to whether any system of piece work rates for designers would be practicable, excepting possibly in companies where new models of similar machines are developed periodically. Letters would be welcome from readers on this subject, whether the system of which they have had experience has been applied to detailing only, or to the engineering department as a whole.

Securing Intermittent Motion

To the Editor:

AS EFFECTIVE means of securing intermittent motion are a frequent necessity in design, I believe engineers will be interested in the excellent example of simplified design employed on a flat wire forming machine. A reciprocating slide that controls the movement of the forming tool is given intermittent motion. This slide moves at a practically constant velocity between its points of reversal and has a similar dwell at each of these points. Also, during each dwell the slide is locked in position, the engagement and release of the locking arrangement being accomplished by the action of the slide itself. This locking arrangement was essential because otherwise the forming operation at each end of the stroke might have displaced the slide and damaged the work.



Simplified mechanism provides intermittent motion with locking at each end

The slide, shown in the accompanying illustration, is actuated through a link *a* and rocker arm *b* by lever *c*. This lever is oscillated at a constant angular velocity by another member of the machine. Arm *b* is pivoted to the machine while it has on its upper end a shoulder screw which is free to slide in an elongated slot in the link. Its lower end engages a pin in the slide. The locking arrangement consists of the block *d* secured to the machine frame and its parts. In this block slide the two spring-actuated fingers *e* and *f*, engaging corresponding notches in plate *g* fastened to the slide.

In the position shown, lever *c* is at its extreme right hand position and the slide is at its farthest left hand point and is commencing its dwell

with plunger *f* locking it in position. As lever *c* swings toward the left, the shoulder screw in the upper end of arm *b* merely slides along the slot, hence no motion is imparted to the slide. However, when the shoulder screw comes in contact with the end of the slot, continued movement of lever *c* will swing arm *b* in a counterclockwise direction and move the slide toward the right. As the slide moves, the beveled side of the notch against plunger *f* forces the latter out of engagement with plate *g*, thus unlocking the slide. Continuing the movement of lever *c* will cause the slide to move to the end of its stroke. At this point plunger *e* will enter notch *h* and again lock the slide. Lever *c* then reverses its motion and the action as outlined is repeated.

The locking plungers and their notch plate are hardened and ground to permit the slide to be locked in both positions accurately. The advantage of the self-locking arrangement is obvious, since costly mechanical movements, sometimes resorted to in locking devices, are avoided without affecting the operation of the machine.

—E. F. EBERHARD,
Bridgeport, Conn.

Smaller Drive Is Feasible with Differential Gears

(*Concluded from Page* 14)

it is obvious that the entire load is handled by the internal gear. If the sun gear rotates in the same direction as the internal gear, the planet spider rotates faster than when the sun gear is stationary; and for the same force on the gear the power delivered to the load is greater, although the power handled by the internal gear remains the same because its speed and force are the same. Therefore, the power handled by the internal gear is equal to the power delivered to the load by the planet spider minus the power handled by the sun gear, or

$$HP_i = HP_p - HP_S$$

or

$$HP_S = HP_p - HP_i$$
$$= \pi D \triangle \delta / (12 \times 33{,}000) - \pi C \Gamma \delta / (2 \times 12 \times 33{,}000)$$

But

$$HP_L = HP_p = \pi D \triangle \delta / (12 \times 33{,}000)$$

and

$$HP_T = HP_S$$

Therefore

$$HP_T / HP_L = 1 - C\Gamma / 2D\triangle$$
$$= 1 - C/(C+S)\triangle$$

Similar calculations can be made for each of the cases given in Table I.

Analysis of the arrangements, performance data and curves reveal the following characteristics of the various combinations.

Cases 1 *to* 6, *Inclusive*

One shaft of the transmission operates at a constant speed. Therefore the capacity of the transmission varies.

An operating range can be selected which permits operation of the output shaft in either direction; but as the output speed approaches zero, the ratio of the load handled by the transmission to the total load approaches infinity.

Operating ranges can be selected in which the output shaft operates in only one direction. To provide a basis of comparison, let ranges be selected in each of which the transmisison carries a load equal to 80 per cent of the total load at maxmum or minimum speed of the output shaft and 20 per cent of the total load at the other limiting speed of the shaft. For each of cases 1 to 6, inclusive, there are two such ranges, (a) and (b), having characteristics shown in Table II.

Cases 7 *to* 12, *Inclusive*

The speeds of both shafts of the transmission vary as the speed of the load shaft varies. It is possible to select conditions under which the belt speed is the same for maximum and minimum speeds of the output shaft, thereby providing full capacity of the transmission at high or low speeds of the shaft.

An operating range can be selected which permits operation of the output shaft in either direction, but in one direction the load handled by the transmission is greater than the load output.

For comparison, operating characteristics of two ranges, (a) and (b), are given in Table II.

For the purpose of handling a constant torque, unidirectional load, it is obvious that the arrangements shown in cases 7 to 12, inclusive, are superior to the arrangements shown in cases 1 to 6 inclusive. It is also apparent that the conditions indicated by the characteristics under (b) are more suitable than those under (a). The selection of the desired characteristics is a matter of connecting the differential elements in such a way as to obtain suitable directions and relative speed of these elements.

It can be seen that in cases 7, 8, 11 and 12 the entire load is handled by the internal gear or the sun gear and that this load must be handled by the planet gears in mesh with the internal or sun gear. In cases 9 and 10 the entire load is handled by the planet gears but it is divided equally between those parts of the planet gears which mesh with the internal gear and those parts which mesh with the sun gear. Therefore, the load on the individual teeth of the gears in cases 9 and 10 is only one-half of that in cases 7, 8, 11 and 12.

Case 10 has an advantage over 9 in that in 10 the output load may be carried direct by the sun gear shaft while in 9 it is necessary to provide a gear, chain or other connection between the internal gear spider and the load. It is not possible to consider all of the possibilities of the drives but, in general, the combination included in case 10, see Table I, is believed to be superior.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

Government Office Transfers Numerous Activities to Standards Body

FOREMOST among standardization topics is the news that the bureau of standards is discontinuing most of the work it has been carrying on in the field of simplification, commercial standards, safety codes and building codes. As an economy measure the government bureau is transferring to the American Standards association the following activities: Division of trade standards, division of specifications, division of simplified practice, building, plumbing and safety code sections. Daniel C. Roper, secretary of commerce, asserted recently that this step was undertaken in the belief that these functions should be in the hands of industrial and consumer groups.

Appreciation of the government's confidence in the ability of the association was expressed by President Howard Coonley in a recent letter to Secretary Roper. He struck a keynote when he said in his letter: "Since the department's action largely is in recognition of the desire of industry to carry on standardization through its own co-operative organization, I have no doubts concerning the ultimate success of our efforts." The move is looked upon favorably by engineers.

* * *

Design Innovations for New Models Include Coiled Springs

NINETEEN-thirty-four auto models will reflect many innovations in design. *Steel's* "Mirrors of Motordom" says that the trend toward the beaver-tail back is apparent in present plans for future cars. Design departments are working out ideas for easier riding. These include return to transverse springs, the adoption of coiled springs or novelties in independent wheel suspension. Buick's plan for independent springing is slated for its 1934 models. This will mean the use of coiled springs.

Reports converge on the probability that the present V-eight type power plant of today's Ford will be toned down and placed in that maker's smaller car to come. Presumably aluminum heads will be discontinued in favor of iron heads, thereby reducing the compression. A cast iron crankshaft with an unusual bearing arrangement may be adopted.

A new use for steel will be found in the 1934 Pontiacs. The harmonic balancers are to be made of heavier pieces of steel to take up forward crankshaft thrust. Harmonic balancers or vibration dampeners as they are known, have been made of light gage strip steel, or even of felt in some automobiles.

* * *

Fuel Consumption Tests Reveal Most Economical Automobile Speed

NOT only among automotive engineers but in all branches of the technical profession results of speed and fuel consumption tests at Iowa State college have created interest. Motorists will obtain the greatest mileage per gallon of gasoline by maintaining a speed of 35 miles per hour, it was found. At that speed the tests disclosed a mileage of 14.5 per gallon on concrete, 13.8 on bituminous-treated gravel and 13 on dry gravel. At 50 miles per hour 12.5 miles were obtained per gallon on concrete, 11 miles on bituminous-treated gravel, and 10 miles on dry gravel; at 60 miles per hour consumption of gasoline on concrete gave 10 miles per gallon, and 8.5 on bituminous-treated gravel.

* * *

Radicalism Has Not Been Created As Result of Unemployment

UNEMPLOYMENT does not foment radicalism among professional engineers, a study recently completed by the Engineering Foundation and personnel research federation shows. Though dissatisfaction with the government and antagonism toward employers as a class was found to be widespread, a genuine political or

economic radicalism is not much greater among idle engineers than among those still employed. Thirty-four per cent of the unemployed interviewed felt that the United States needs a strong dictator, and 19 per cent of a comparable group of employed felt the same way.

* * *

Unconventional Airplane Developed Secretly in Germany

WORD emanates from aviation circles that a new airplane, the idea of Adolf Rohrback, noted German aviation designer, has been developed but is being held secret until experiments can demonstrate its practicability. Rohrback says it can fly forward, backward, hover motionless or rise or descend almost vertically. According to reports, it has no propeller or wings; locomotion and lifting power are supplied by revolving devices which project from the fuselage in place of wings. These devices are six-blade horizontal fins revolving in a circle around two axial bars connected with the motor that is inside the plane.

* * *

Engineers Can Aid in Solution of Economic Problems

ENGINEERS can be of assistance in solving the problems of today's complex society, Dr. Dexter S. Kimball set forth in an address recently. The technical man today has complete mastery over the economics of production and can predict with some certainty not only the scientific characteristics of his product, but also its economic performance. And it should be specially noted, Dr. Kimball declared, that in so doing he has developed a knowledge and a control of the human element in industry that would have appeared to be impossible fifty years ago. For the most part this extended knowledge of modern industry is the exclusive property of the engineering profession. If the engineer can apply his analytical methods and develop the basic facts through his more intimate knowledge of industry, he can indeed become a most useful factor in public life.

* * *

Steel Treaters Soon To Be Known As American Metals Society

AMERICAN Metals Society will be the new name of the American Society for Steel Treating if the recent unanimous resolution of the board of directors is ratified by the members of the organization. Reasons for changing the name of the A. S. S. T. are given as follows: The society long since has extended its field far beyond the single aspect of steel treating; members often have called the attention of the officers and directors to the fact that considerable confusion has arisen from time to time because of the implied limitations of the present name; scope of activties include a large proportion of nonferrous as well as ferrous interests; the new name is in harmony with the society's purposes which is to promote the arts and sciences connected with the manufacture, treatment, and uses of metals.

The subsequent step following the action of the directors will be to refer the resolution to the constitution and by-laws committee at the annual meeting to be held in Detroit, Oct. 2 to 6. The amendment then will be submitted to the entire membership by letter ballot and will become effective when ratified by a majority of the members. It is felt that the new name will become official by the first of the year.

* * *

Laboratory Tests Are Completed on New Speed Boat Propellor Shafts

FINAL laboratory tests on the monel metal propeller shafts for Gar Wood's Harmsworth trophy defender, MISS AMERICA X, have been completed and reveal a high range of physical properties. They have been shipped to Detroit for tests in actual service. This is said to be the first time that a nonferrous material has been employed where such tremendous power has been involved, although monel metal shafts have been used widely for pleasure and racing craft. Each of the twin shafts on MISS AMERICA will be required to transmit 3170 horsepower.

* * *

Detroit Metal Show Will Be Largest Since That Held in 1929

MORE than 100 companies had reserved nearly seventy-five per cent of the available exhibit space by the early part of August for the National Metal Exposition which opens in convention hall, Detroit, on Oct. 2. This is far in excess of the total space used at the Buffalo show last year and assures the largest exposition since 1929. Technical programs are planned by the American Society for Steel Treating and other groups including the American Welding Society, American Institute of Mining and Metallurgical Engineers (Institute of Metals and Iron and Steel divisions), and the Wire association.

Design for the Eye!

By William B. Stout

GREAT changes are taking place in the world's transportation as well as in its humanity. New items of engineering are developing almost hourly, most of which are applicable to some phase of transportation—and transportation constitutes about 85 per cent of all human labor.

Conquering this world is still a battle of ingenuity and always will be, and when all is said and done it is not the automobile engineer or the executive or the sales manager who runs the automobile business. The sales department cannot sell a vehicle the public does not want; the manufacturing department wastes its time building a vehicle that cannot be sold; the engineering department finds it impossible to design a motor car of any value by the use of the slide rule alone, for after all there is old John Q. Public and his wife and the friends he goes with that determine what is going to be purchased.

You can build a car as radical as you wish and as freakish as you may desire; and if, when you set it on the road, it is fundamentally more beautiful than any previous automobile, you have made a tremendous start. You have sold the eye, and the eye is the hardest thing to unsell once it is sold.

No firm today has designed a long distance touring car which combines head room, luxury, baggage space and equipment consistent with day and night touring over an extended period, and stayed in line with the requirements of a city vehicle for all ordinary uses. It is quite probable that in the near future old John Q. will respond to a vehicle complete in itself and somewhere half way between the present touring car and the most luxurious trailer.

The grave mistakes in any line of engineering or industrial progress are practically always made in the assumption rather than in any detail of methods or building. The time has come when the assumptions on which the motor car business is based must be reshuffled to fit the new psychology of business, the new type of roads available, the new speeds required both for touring and city work, and the great reduction in fatigue for driver and passenger that is going to be necessary for all long distance work.

Light Weight Fundamental

Light weight must be a fundamental of the future car. Again we are getting to a type of roughness on the roads which is entirely different from the roughness on roads of the past such as in gravel ruts and on mud surfaces. Tramping of the front wheels on concrete, first one and then the other at certain synchronous speeds, is far worse than the roughness of the old dirt roads. Shimmy of the front wheels at any time is more dangerous than the designer is willing to admit. Complete elimination of both of these is hardly possible without the individual springing of every wheel without using definite cross axles.

When we come to the controls of the car, there are many other items. John Public is all through buying cars which cannot be steered with one finger and without fatigue on high speed trips. He wants his brake to work with just a touch of the foot without any possibility in any emergency of a grabbing brake or a chatter. Brakes must be smooth and velvety and perfectly equalized on both pairs of wheels, with just the proper pressure comparatively fore and aft to fit the particular balance of that individual make of car.

The lighter a car is, the easier it can be made to ride; the less the weight is, the greater is the comfort. And when we are getting down to cases on this light weight, we find that it can bring not only better tires, better steering and less fatigue of control, but new types of powerplants, transmissions and what-not made possible only because of the greater power per pound available in the vehicle. Within five years we will see motor cars without gearshifts that will be able to climb our steepest highways on high gear without any effort at all.

A NEW physchology of business has arisen that considers the consumer to a greater degree than at any time in the past. Disciples of this creed are especially numerous in the automotive industry, yet every designer of machines will be repaid by consideration of some of the precepts defined by Mr. Stout, president, Stout Engineering Laboratories Inc., at the recent International Automotive Engineering Congress in Chicago.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

MORE than 100 patents pertaining particularly to the field of control equipment have been taken out by Frank E. Case, who recently retired from the General Electric Co. He was assistant to the engineer of the transportation department and had been in the service of the company for 42 years.

Mr. Case entered the employ of the Thomson-Houston Electric Co., Lynn, Mass., in 1891, shortly before the formation of General Electric. In 1894 he was transferred to the Schenectady works, where for 20 years he was engineer of the railway equipment department. He, with his department, transferred in 1926 to the Erie works, there being placed in charge of motor and locomotive design divisions in addition to railway control. In 1930 the design sections of the transportation department were consolidated with the general engineering division, and Mr. Case became assistant to the engineer.

On four occasions he was sent to Europe in connection with engineering problems of foreign customers of his company. During one of these visits he worked several weeks on the initial 1500-volt electrification of the Paris-Orleans railway. He also was intimately connected with the earlier subway installations of the metropolitan underground railway in London.

BY VIRTUE of his familiarity with both technical and scientific needs of industry, Dr. William Elgin Wickenden is exceedingly well qualified to carry out the duties of his new office as president of the Society for the Promotion of Engineering Education. As the head of Case School of Applied Science, Cleveland, he has an opportunity to put into practice vital educational trends and to observe their effects on the rising generation of engineers.

From Toledo, where he was born Dec. 24, 1882, he set out as a youth, for Granville, O., to enter Dennison university. Holding a job as newspaper reporter did not interfere with his scholastic standing during his college career, for in 1904 he was presented with a Phi Beta Kappa key in addition to his diploma. The next fall he became instructor in physics and applied electricity at Rochester Mechanic's institute. Feeling a need for more training he became a graduate student and assistant in physics at the University of Wisconsin.

His subsequent step in teaching took him to Massachusetts Institute of Technology, where he was assistant and later associate professor of electrical engineering. Leaving M. I. T. he became personnel manager of Western Electric Co., in 1918, assistant vice president of the American Telephone & Telegraph Co. in 1921, and director of investigation of the Society for the Promotion of Engineering Education in 1927. Case school obtained him as president in 1929. Dr. Wickenden holds membership in numerous technical organizations.

FOR his outstanding achievement in the metal casting industry Guilliam H. Clamer has been awarded the Joseph S. Seaman gold medal of the American Foundrymen's association. Supplementing this honor he also received recently the honorary degree of doctor of science from Ursinus college for his scientific work.

Philadelphia was his birthplace, June 9, 1875. He obtained his early technical training in the city manual training school and later at University of Pennsylvania. Upon graduation with a B. S. degree in chemistry, Mr. Clamer established a chemical laboratory at the Ajax Metal Co., Philadelphia, with which organization he since has been associated. He was one of the first, if not the first chemist to be employed regularly in the nonferrous foundry industry.

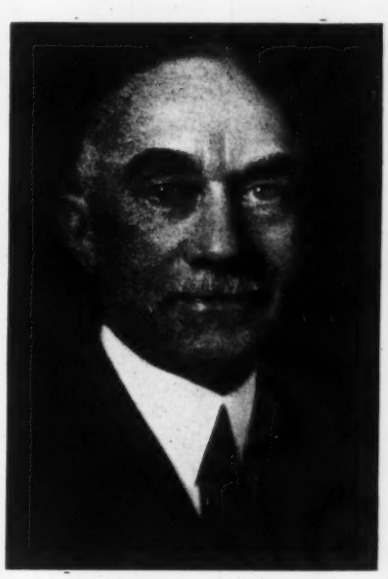
Mr. Clamer experimented with ferrous alloys, leading to the invention of the refining process in 1901 for which he was awarded the Elliott Cresson medal. Research and development of the induction type of furnace also were carried on by him, and as a result of his efforts remarkable changes in the melting practice in brass mills have been effected.

WHEN a sticking valve brought failure to the recent Piccard stratosphere flight in Chicago it also prevented Lieut.-Commander T. G. W. Settle, the pilot, from adding another achievement to his colorful record in aeronau-

Leaders in Design, Engineering and Research

FRANK E. CASE

W. E. WICKENDEN



G. H. CLAMER

T. G. W. SETTLE

tics. Although noted primarily for his daring as a balloonist, he is a serious student of aviation engineering. His all-around experience in the aeronautical field qualified him to act as senior inspector during the construction of the AKRON and MACON at Akron, O.

Born in Washington Nov. 4, 1895, Lieut.-Commander Settle entered the United States Naval academy in 1915 and was graduated three years later, standing number two in his class. After naval service which extended through the duration of the war, to 1922, he took post graduate work, spending one year at Annapolis and one at Harvard, in electrical and aviation engineering. He then was posted to Lakehurst to serve first on the SHENANDOAH and later on the LOS ANGELES, as radio engineer, and finally executive officer on the latter ship.

* * *

Major R. A. Bull has terminated his connection with the Steel Founders' Research group and expects to engage in private consulting practice. He will maintain headquarters at 541 Diversey Parkway, Chicago. Major Bull has been a contributor to MACHINE DESIGN.

* * *

John Wahl, who developed the Wahl Eversharp pencil, has taken charge of experimental engineering and design at Mills Novelty Co., Chicago. He has contributed some outstanding ideas in coin machine construction.

* * *

Roy E. Cole, chief engineer, Rockne Motors, who is on an indefinite leave of absence to carry on engineering development work, has opened an office in Detroit.

* * *

George S. Jones, formerly designer with St. Regis Paper Co., manufacturer of paper bag filling machines, Oswego, N. Y., now is with the Sealright Co., Fulton, N. Y., in a similar capacity.

* * *

Prof. John M. Russ has accepted an appointment as associate professor of engineering drawing at Ohio State university, Columbus. He formerly was associate professor of practical mechanics at Purdue university.

* * *

Dr. Jerome Clarke Hunsaker, vice president of Goodyear-Zeppelin Corp., and distinguished aeronautical engineer, has accepted appointment as head of the department of mechanical engineering of Massachusetts Institute of Technology. He succeeds the late Prof. Edward F. Miller, for many years head of the department. A picture and biographical sketch of Dr. Hunsaker appeared on pages 40 and 41 of the July issue.

* * *

W. C. Harris, has been appointed assistant engineer of the transportation department of the General Electric Co. at Erie, Pa.

* * *

Clarence B. Randall, vice president of the Inland Steel Corp., recently was presented with the American Iron and Steel institute medal.

* * *

Mead F. Moore has been appointed chief engineer of Nash Automobile Co., Kenosha, Wis., by N. E. Whalberg, vice president in charge of engineering.

* * *

Penrose R. Hoopes, consulting mechanical engineer, Hartford, Conn., has been retained as technical consultant by the Selas Co., Philadelphia, which recently expanded its business to include the design of special machinery for industrial heating processes.

* * *

D. J. McAdam Jr., bureau of standards, recently was awarded the Longstreth medal by the Franklin institute for his work in helping to establish the fundamental principles of corrosion fatigue.

* * *

W. P. Wiltsee, chief engineer, Norfolk & Western Railway Co., has been elected president of the American Railway Engineering association.

* * *

T. S. Taylor has established testing and engineering research laboratories at Caldwell, N. J. He formerly was chief research physicist of Bakelite Corp.

* * *

L. A. Bauer now is in the engineering research department of Edw. G. Budd Mfg. Co., Philadelphia. He formerly was with the American Airplane Corp.

* * *

W. E. Miller, mechanical and electrical superintendent, Bethlehem Steel Co., Johnstown, Pa., has been elected president of the Association of Iron and Steel Electrical Engineers.

* * *

George B. Karelitz has resigned as manager of the marine engineering division of Westing-

(*Concluded on Page* 61)

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

DESIGNED to disengage automatically the driving and driven members at a predetermined overload value, a new type of shaft coupling, Fig. 1, employs a body of practically incompressible liquid between the movable walls of a closed chamber 17. The chamber is so related to a series of teeth 8 and 10, *C*, that it tends to contract in capacity as the teeth tend to move apart, but is prevented from doing so by the presence of the liquid. Pressure of the

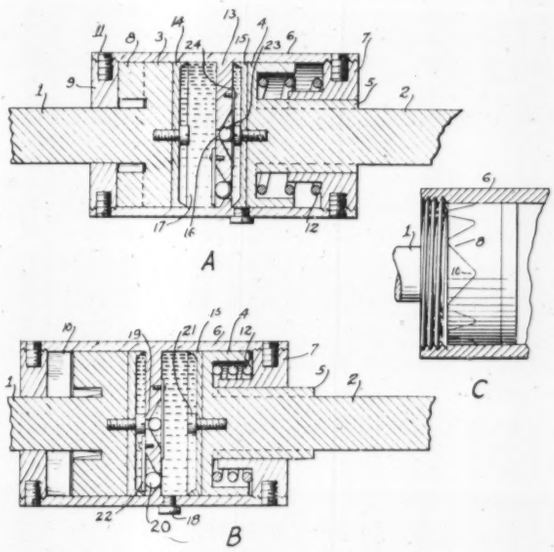


Fig. 1—Liquid in chamber of shaft coupling guards against overload of mechanism

torque thus is transmitted to the liquid which fills the chamber, provision made so that when the torque exceeds the value predetermined as the release point of the coupling a component of pressure of the liquid, of predetermined small value, acts to open an outlet for the liquid, which escaping from the chamber permits the teeth to unmesh.

Top drawing *A* in the illustration shows the parts engaged; *B*, disengaged. The series of teeth 8 is on the outer edge of piston head 3, while the adjacent end of cylinder 6 closed by cylinder head 9, slidable on shaft 1, is provided with teeth 10. It is obvious that in the absence of supplementary mechanism, the driving torque will tend to separate the driving and driven teeth, the sloping sides of one series sliding outward against the sloping sides of the other series.

Cylinder 3 will move to the right just as soon as the differential between the forces exerted exceeds the pressure value acting upon the area of aperture 16, which is closed by transfer valve 23, and reaches a point at which the pressure of spring 12 is overcome. When once disengaged the driving and driven elements run free, there being no return of liquid until valve 20 has been opened manually or otherwise moving the cylinder 6 into teeth engaging relation. The coupling was designed by Edwin K. Le Fevre, granted patent No. 1,919,437, assigned to Whitfield Engineering Co., District of Columbia.

TO OBVIATE the necessity for skill in the tedious operation of striping rubber balls and other spherical objects by hand, the late Charles W. Steele designed for the B. F. Goodrich Co., Akron, O., a machine to perform this task. The unit, Fig. 2, automatically spaces the stripes and can be operated by unskilled labor. A patent, No. 1,919,386, recently was issued to cover the mechanism.

Depression of a foot pedal at the bottom of rod 33 retracts the tailstock spindle 17 after dis-

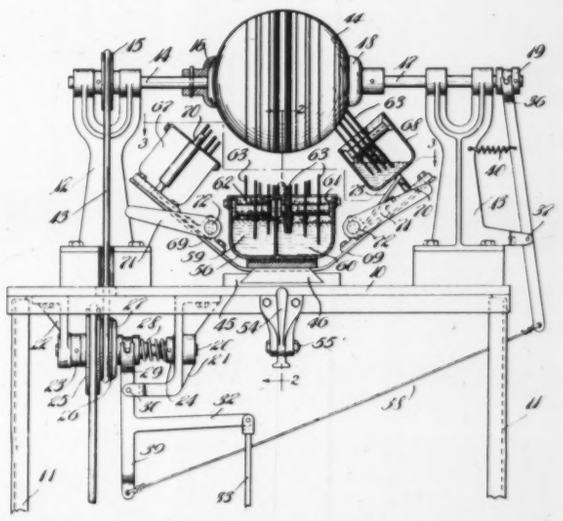


Fig. 2—Knurled paint wheels apply stripes to revolving rubber balls

connecting the headstock spindle 14 from the source of power, and braking it, to enable the operator to place and remove the balls. To apply the striping to the equatorial region of the ball the striping mechanism includes a dovetailed guideway 45 mounted on the table, and a corresponding slide 46 on which the striping devices are carried. Paint wheels are of different diameters and are provided with knurled peripheral margins.

In order to stripe the polar regions, paint pots 67 and 68 are provided. A hand lever 71 pivoted at 72 on plate 69 has an arm 73 engaging under paint pot 68 for raising it toward the ball. A similar independent lifting mechanism is provided for paint pot 67.

TO deliver intermittant rotation to a driven shaft from a continuously rotating driving shaft, Ernest S. Carpenter has designed the arrangement shown in Fig. 3. A patent, No. 1,-920,969, recently was granted to cover the invention. The Augustus-Carpenter Co., Cleveland, is assignee.

This device is adapted for use in a motion picture projector for progressing the film. Shaft 10 carries a cam 20. Peripheral groove 21 extends nearly the entire circumference, diverting at one end (as at 22) to the right-hand edge of the wheel, and at the other end to the left-hand edge.

The driven member comprises a wheel 30 equipped with radial pins 31, any one of which may occupy the groove of the driving cam, while the adjacent pins on opposite sides during the period of rest engage the chamfered edge 24. During the period of movement of the driven wheel, the pin which was in the straight groove

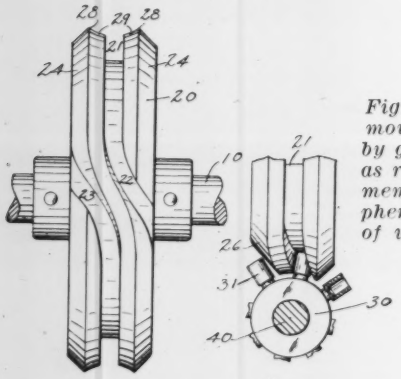


Fig. 3 — Intermittent movement is provided by grooved driving cam as radial pins of driven member engage peripheral groove, the ends of which are diverted

21, passes out through the diverted portion, while the next pin comes into the groove through the other diverted portion. Movement of the driven shaft takes place when the pins reach the diverted portion of the groove.

COMPACTNESS characterizes the hydraulic steering gear designed and patented recently by Albert R. Kuzelewski for the American Engineering Co., Philadelphia. As shown in Fig. 4, rams 1 and 2 operate in two parts of aligned cylinders 3-4 and 5-6. By suitable mechanism fluid pressure is applied to the cylinders through piping 25 and valves 26 and 27 to actuate rams 1 and 2 simultaneously in opposite directions. Pumps 7 and 8, operated by electric motors 9 and 10, deliver fluid pressure.

Rams 1 and 2 are connected respectively through rods 11 and 12 with arms of yoke 13

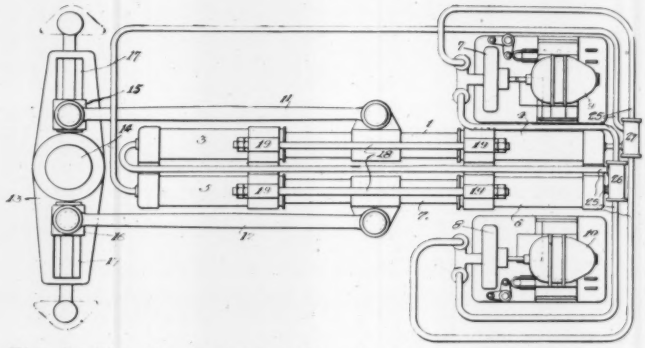


Fig. 4—Simultaneous, opposite actuation of rams in hydraulic steering gear effects balance

carried by rudder post 14. Advantage is taken of the simultaneous opposite movements of rams 1 and 2 to effect a balanced condition which largely eliminates excessive unbalanced stresses and permits use of relatively light foundation structure, resulting in economy in space. According to the patent, it has been customary in devices of this type to form the ram cylinders separately. These individual cylinders or the aligned pairs of cylinders were inherently unstable and required relatively large foundation structures to provide the necessary stability.

The patent is designated No. 1,917,528.

Review of Noteworthy Patents

Other patents pertaining to design are described briefly as follows:

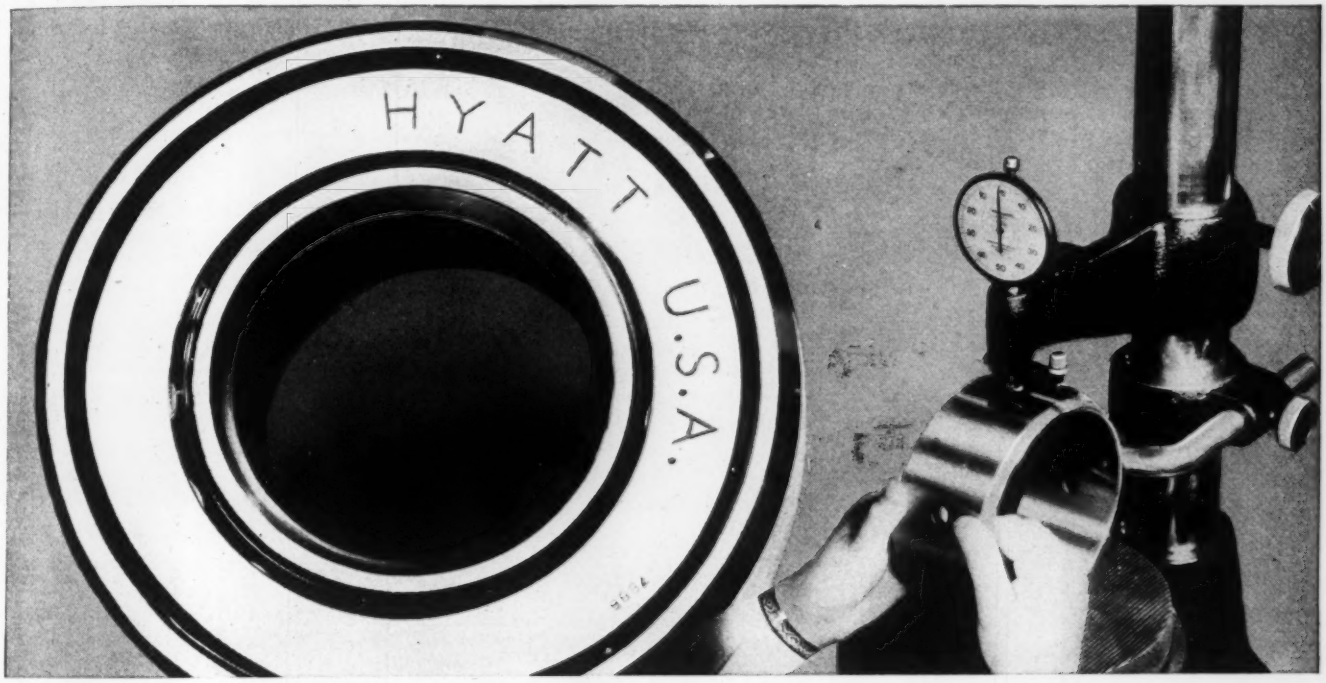
ELASTIC FLUID TURBINE, 1,922,074. The invention comprises a turbine having a plurality of individual nozzle sets, each of which includes one or more nozzles designed to operate the turbine at a particular speed. Assigned to B. F. Sturtevant Co., Hyde Park, Mass.

FRUIT CUTTING, JUICE EXTRACTING UNIT, 1,922,-818. This invention relates to machines for cutting citrus fruits in pieces and extracting the juice by a rotary scraping or reaming operation. Assigned to Hoffman Beverage Co., Newark, N. J.

FULL-FASHIONED KNITTING UNIT, 1,920,435. The object of this invention is to provide means for lengthening the stitches of the main yarn in the areas where a reinforcing or plating thread is used. Assigned to Schletter & Zander Inc., Philadelphia.

ENGINE CONTROL MEANS, 1,919,536. This patent covers an electric governor associated with the timer mechanism of internal combustion engines to control speed. Assigned to Nafziger Corp., Kansas City, Mo.

RECOMMENDATIONS
WHICH REFLECT
GOOD JUDGMENT

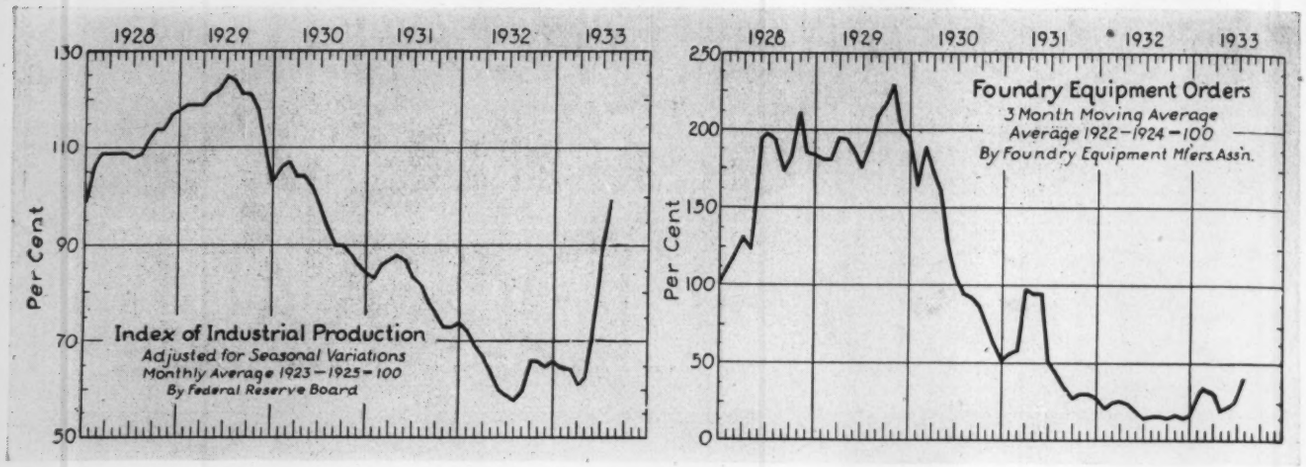


If, forty years ago, you selected Hyatt Roller Bearings for your machines — you might have been excused for your daring.

Today the story is different. Choosing Hyatts is proof of your good judgment. Your own experience, and that of your business associates, has shown that Hyatts deliver extra efficiency in friction reduction on every job. Their performance year after year is positive assurance of value, and a compliment to your choice.

That is why we only need to say to the younger generation of engineers: Hyatt's control of quality has increased with the years to a point where "Hyatt Equipped" means bearings as excellent in design, manufacture and performance as the machines or equipment they protect. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, Oakland.

HYATT
ROLLER BEARINGS
PRODUCT OF GENERAL MOTORS

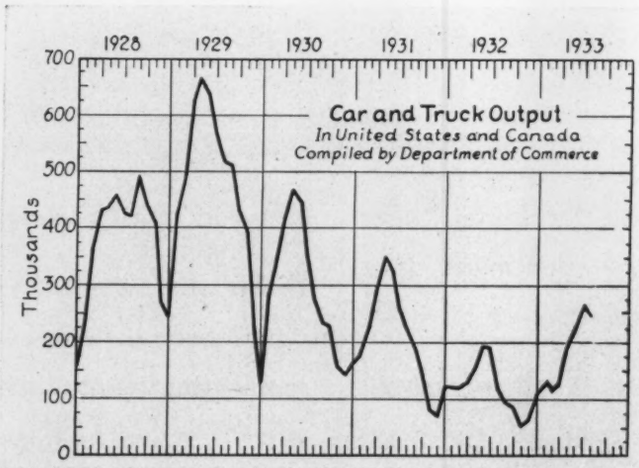


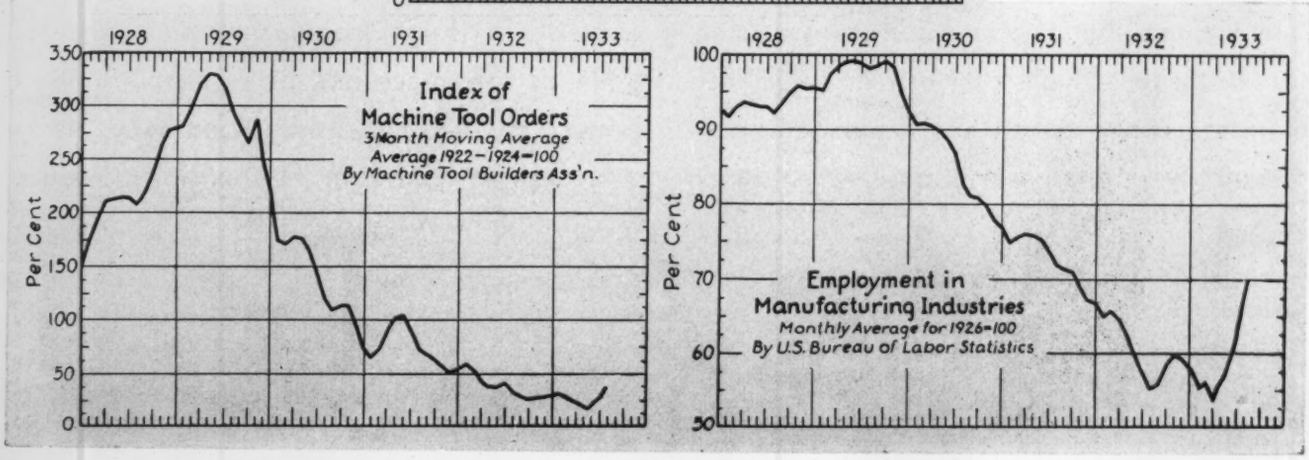
How Is Business?

ONE of the indexes of business which does not attract a great deal of attention, yet one that accurately forecasts the trend for industrial production is the index of marketings of agricultural products. Back in 1932 this faithful indicator started upward. Industrial production now reflects the trend.

But this is not the only instance of accurate prediction. This index plotted together with that of industrial production will show that for the last fifteen years the up and down swings of industry have been indicated about one year ahead by agricultural marketings. Industrial production not only follows by about a year, but its swings are exaggerated over those of marketings. Its peaks are higher, its bottoms lower.

It would pay to keep a closer tab on agricultural marketings. The present upturn was predicted, and now it would appear that 1934 will be even more prosperous as marketings for the first part of 1933 are averaging 50 per cent higher than during the same period in 1932. Furthermore, all indications are that the percentage of increase will be even greater during the last half of the year. Twenty-five per cent of the total population lives on farms, one-eighth of the railroad freight is farm products. Farm prosperity is necessary to all classes of industry.





For Dependable Performance

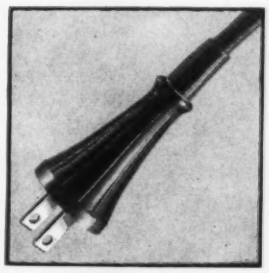
Use the GENERAL ELECTRIC

ALL-RUBBER PLUG

Since the introduction of the All-rubber plug by General Electric, many imitations have appeared on the market. Simple, practical tests however, will prove the superiority of the G-E Plug. Close examination and comparison will reveal its one-piece construction which is an exclusive G-E Feature. Because it is moulded under moderate temperature at high pressure, it can not come apart and will out-live any cord.

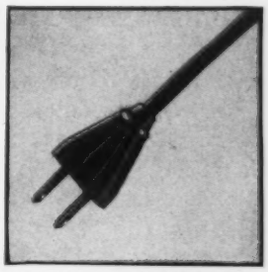
These high-grade plugs will add quality and individuality to your appliances. They are built to withstand hard wear and rough usage, thus assuring dependable performance and minimizing consumer complaints.

G-E All-rubber Plugs can be moulded onto any type of silk, cotton, rubber, asbestos or heater cord. Approved by National Board of Fire Underwriters.

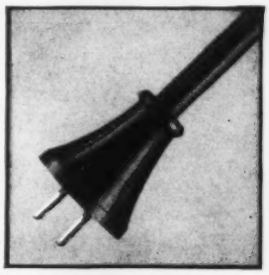


STANDARD

JUNIOR

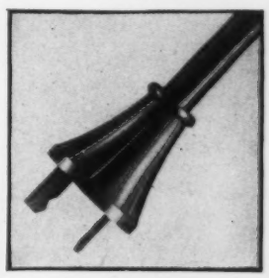


MIDGET

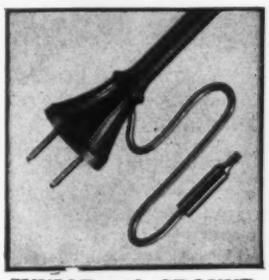


HEAVY DUTY

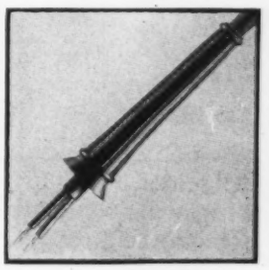
3-POLE



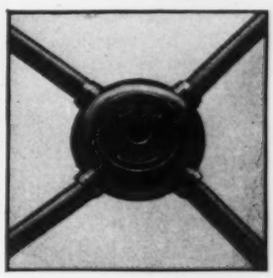
20-AMPERE



JUNIOR with GROUND LEAD and PLATE SCREW TERMINAL



RUBBER STRAIN RELIEF



DELTA CONNECTION

We want to know more about the G-E All-Rubber Plug.
We want to consult with one of your Accessory Equipment specialists.

Name.....

Address.....

City.....

GENERAL ELECTRIC

ACCESSORY EQUIPMENT

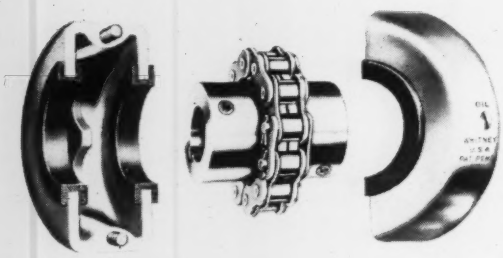
MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT

NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Coupling Has Protective Cover

FLEXIBLE couplings consisting of two chain sprockets coupled together with roller chain are being marketed by Whitney Mfg. Co., Hartford, Conn. Proper clearance between the two sprockets allows for slight shaft misalignment. This clearance also gives a reasonable amount of motor end float without binding or shaft distortion. The construction allows quick installation or dismantling of equipment. The cover for the coupling has been developed to give proper lubrication and protection from dirt, grit and abrasive materials. In addition, it provides safety and improved appearance on machines on which it is used.



Motor end float without binding or shaft distortion is permitted by coupling

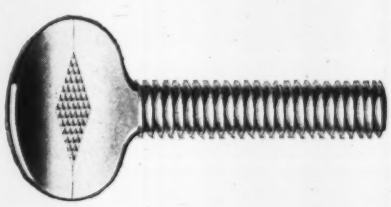
Cable Employs Rubber Insulation

THREE new types of rubber insulated cable, insulated with heat, corona and moisture resisting compounds, have been brought out by General Electric Co., Schenectady, N. Y. Rubber insulation designated as type GE-R359 is designed to operate at a maximum temperature not exceeding 75 degrees Cent. It is recommended for insulating cables for motor lead and power applications where a cable is required to be insulated with a compound which will stand the higher temperatures.

The type GE-R348 moisture resisting compound is designed for use on cables which must operate in wet locations. Type GE-R351 is a corona and moisture resisting compound. It is planned for high voltage transmission, distribution, submarine and similar applications where a corona resisting, high tension, nonleaded or leaded cable is required.

Thumb Screws Are of One Piece

COLD forged thumb screws made in one piece by a new and improved process have been introduced by Parker-Kalon Corp., 200 Varick street, New York. The thumb grips of the screws, shown herewith, are shaped to have pleasing proportions. Because they are free of burrs and roughness, they take a good plated finish. The knurling provides a firm finger grip. Screws are rolled-threaded to close limits. They are made for stock in a complete range of sizes from 3/16-inch 24 by ½ inch to ⅜-inch—16 by 3 inch inclusive.

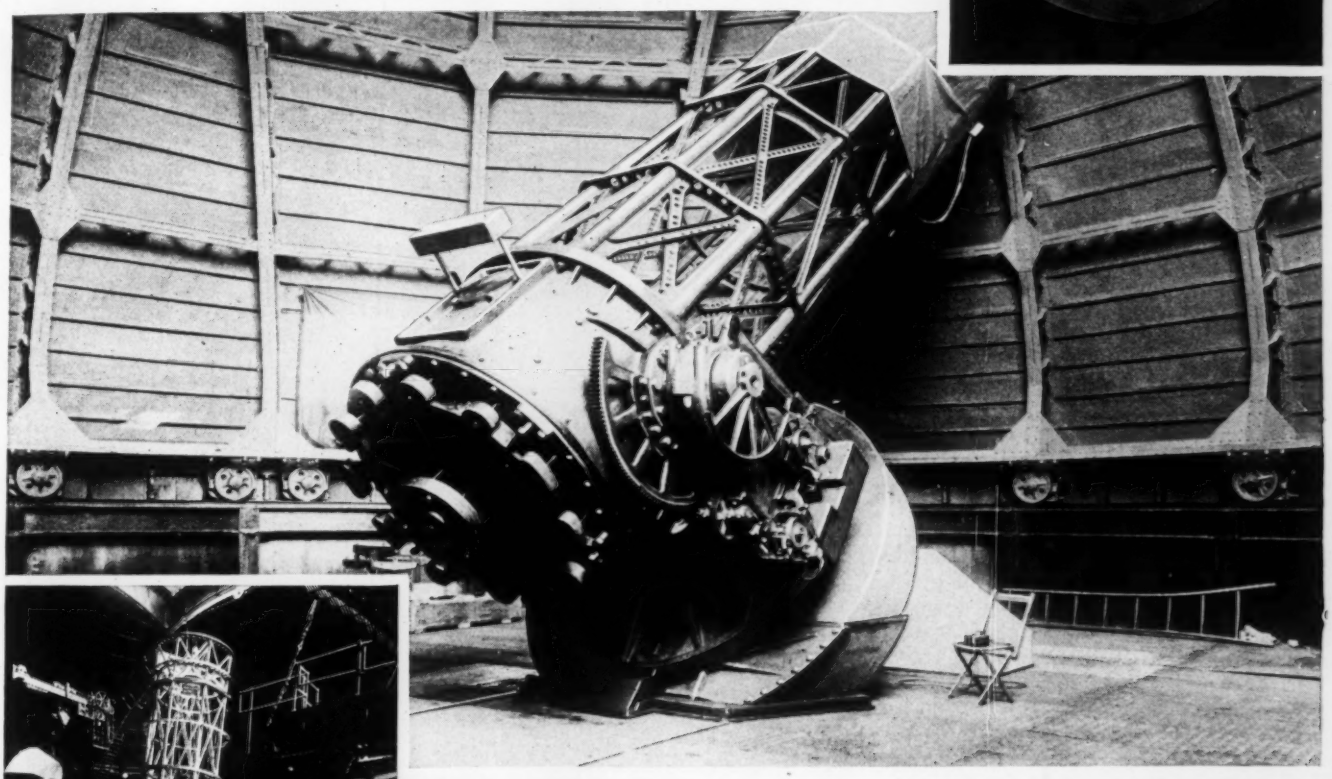


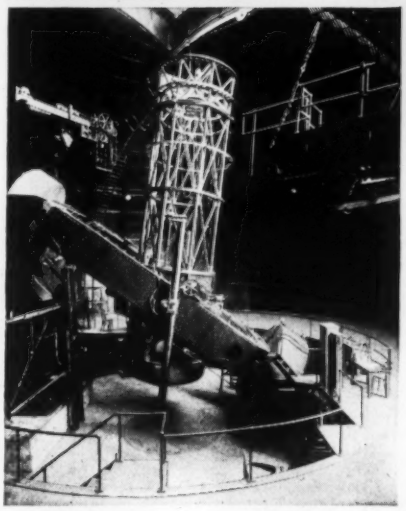
Thumb screws made from one piece will take a good plated finish because of the unique method of manufacture

Photoelectric Kits Introduced

PHOTRONIC control kits which are being marketed especially for engineers who prefer to do their own experimenting with photoelectric control for mechanical equipment, operations etc., have been brought out by Weston Electrical Instrument Corp., 614 Frelinghuysen avenue, Newark, N. J. The kits contain all equipment necessary for the engineer to start immediate experiments, together with diagrams of connections. The equipment can be used as

PART OF THE EYES OF THE EARTH FOR 27 YEARS





100-inch reflector telescope at Mount Wilson Observatory equipped throughout with SKF Bearings.

•

Center: — *60-inch reflector telescope at Mount Wilson Observatory built in 1906, SKF-equipped.*

•

Top at right:—*One of the SKF Bearings installed in the Mount Wilson Observatory 60-inch reflector telescope in 1906. 46 of these bearings are still in use.*

3078

SKF Bearings on Mount Wilson Observatory Telescope Since 1906 Still in Service

Many and varied are the uses of SKF Bearings...which is just another way of saying that many and varied are the *demands* for bearing quality ...for bearing precision...for bearing performance.

For example, 47 SKF Bearings of a now obsolete type were installed on the 60-inch reflector telescope of Mount Wilson Observatory in 1906. Recently, during a general overhaul period, the bearings were inspected and 46 of the 47 were re-installed. Just one bearing had reached the end of its useful life after more than a quarter century. The old-fashioned ball retainer had broken. Today, not only the old 60-inch telescope but the new 100-inch reflector is operating on SKF Bearings.

All of which proves that whether you are engaged in gazing at the moon or in gazing at a table of operating costs . . . in a bearing, Performance is the thing that really counts!

SKF Industries, Incorporated
40 East 34th Street, New York, N. Y.

SKF

BALL AND ROLLER BEARINGS

a safety device on machines, smoke detector, door opener, counter for all classes of service, etc.

Chart Instruments Are Improved

CIRCULAR chart instruments eight and twelve inches in diameter in an entirely new line have been placed on the market by Brown Instrument Co., Philadelphia. These instruments include thermometers, shown herewith, in indicating and recording types for temperatures from minus 40 to 1200 degrees Fahr., and indicating or recording pressure and vacuum gages for ranges from 10 inches of water up to 5000 pounds. All types are offered in one, two or three pen models.

The improved mercury-filled helix on the thermometer line is built of a stainless steel which

Mercury filled helix on thermometer line will withstand considerable overload as it is made of stainless steel

will withstand 100 per cent overload and provides a surplus of power to move the pen. Gas and vapor type helices are made of heat treated phosphor bronze.

Introduces Improved Air Valve

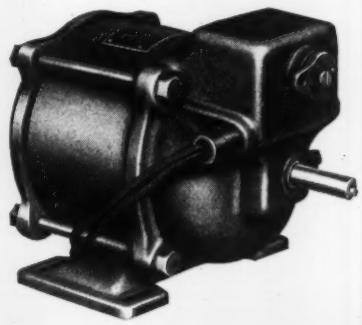
DEVELOPED primarily for the return of the compressed air from the exhaust side of the cylinder, and to allow only enough live air to pass through the auxiliary valve to operate attached equipment, the Minard air valve and oil filter now is being marketed by Detroit Tool & Forge Co., 656 Smith avenue, Detroit. This valve can be used in connection with any double acting air cylinder where the minimum amount of air consumed is a feature in the performance of air operated reciprocating equipment and fixtures.

The filter is designed to prevent scale, dirt, etc. in the air line from being carried into the valve or revolving connection, packing, etc., of any make of air valve or cylinder. It insures lubrication and prevents rust by mixing oil with the air in the form of a spray. The unit can be used with the valve mounted in a horizontal, vertical or angular position as required.

Motors Are Explosion Proof

EXPLOSION proof gasoline pump motors available in split phase, repulsion start single phase and direct current types have been

Rolled steel is used for the frame of explosion proof motors which have cast iron end brackets



introduced by Century Electric Co., St. Louis. The frame of the motor, shown herewith, is of rolled steel with cast iron end brackets. There are no removable plugs or caps. The switch and motor shaft bearing housings are both flanged and drained to prevent liquid gasoline entering the switch closure along the switch shaft, or the oil well along the motor shaft.

The switch is a double pole circuit breaker provided with thermal overload protection that trips free and cannot be held closed under sustained overload. It is completely enclosed inside the cast iron end bracket.

New Strip Heaters Introduced

DOUBLE ended electric heaters with one and two terminals at each end have been designed to supplement the standard line of heating units manufactured by Harold E. Trent Co.,

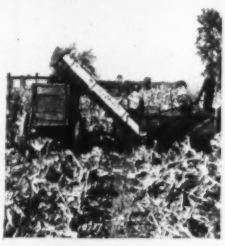
Heating units are available made of stainless steel, copper or other materials

618 North Fifty-fourth street, Philadelphia. The heater, shown herewith, consists primarily of one terminal at each end of a tubular strip. They can be made from a few inches in length up to 22 feet and can be made of rust resisting

NICKEL . . .

GOES BACK TO THE SOIL AND BRINGS NEW EFFICIENCY TO AGRICULTURE

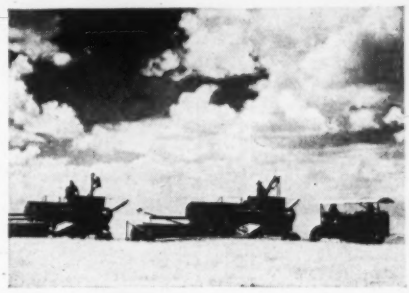
FARMING is no longer a business of back-breaking toil and slow-moving horse power. The primitive methods of former days have steadily given way to ingenious equipment that does the work more easily, more quickly and more economically.



Where formerly tractors were operated at speeds comparable with those of "Old Dobbin," rubber-tired tractors are now available with top speeds of more than 30 miles an hour. This means that all types of tractor-drawn or tractor-powered equipment must be redesigned for higher speed operation.

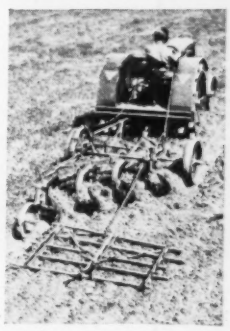
Today there is scarcely any type of agricultural implement that could not be improved through the use of materials more resistant to the destructive forces of wear, stress, abrasion, corrosion, fatigue and shock. The same is true of the equipment used in other leading industries.

When nickel is combined with other metals under suitable conditions, a wide range of improved properties results . . . properties that enable the machinery manufacturer to turn out products that are more powerful, more enduring and more economical to operate and maintain.



No matter what properties you demand of a material or what purpose it must serve, there is available a commercial nickel alloy suited to your requirements. These nickel-alloyed materials come in a variety of compositions, each carefully established by exhaustive laboratory tests and field service.

We have an extensive experience data on the uses of nickel alloy steels, nickel cast irons, nickel bronzes, and other nickel alloys, and will be glad to send you full information on any application. Our engineers have had broad experience in the solution of problems involving the use of nickel. You may feel free to consult them at any time.



Nickel Alloy Steels

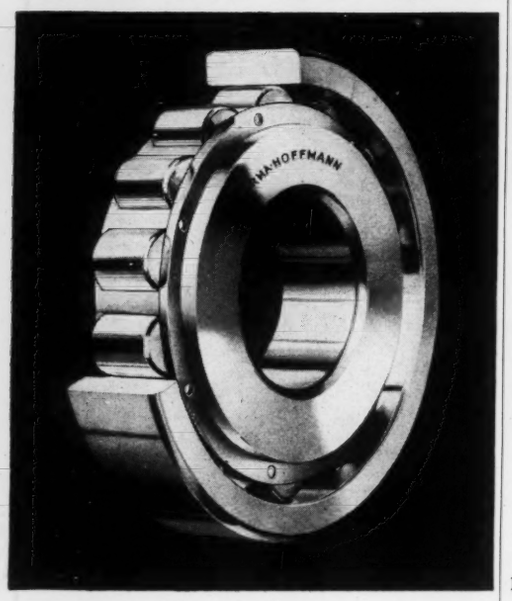
Among the most widely used alloys containing Nickel are the Nickel Alloy Steels—steels of vastly improved grain structure, strong, tough and highly resistant to shock and wear. One prominent tractor manufacturer uses 940 lbs. of Nickel Alloy Steel in every Diesel-powered model to assure greater freedom from wear and breakage. Nickel Alloy Steels are also used extensively in building automobiles, aircraft, locomotives; and in construction, agricultural, mining, oil, lumber and milling equipment . . . in fact, wherever the job calls for superior strength and toughness.

THE INTERNATIONAL NICKEL COMPANY, INC.

Miners, refiners and rollers of Nickel.
Sole producers of Monel Metal.

67 Wall Street - New York, N. Y.

for **SEVERE RADIAL** *and* **SHOCK LOADS**



PRECISION ROLLER BEARINGS afford—for extreme load conditions—the following outstanding advantages . . . Solid, cylindrical rollers, held to infinitesimal limits of accuracy, provide larger steady load and shock capacity than any other single-row bearing, together with a temporary overload capacity of 50% . . . Short roller construction affords ideal load distribution and greater wear resistance . . . Extruded bronze, machined and balanced, heavy-duty retainer is land-riding, relieving the rolling elements of its weight . . . Extreme refinement of design and finish gives a lower coefficient of friction under severe load than any other type of bearing and permits speeds up to 35,000 R.P.M. . . . PRECISION ROLLER BEARINGS interchange in size with all standard ball bearings . . . Write for the catalog. Let our engineers work with you. . . . . .

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP. STAMFORD, CONN., U. S. A.

steel, stainless steel, copper or other metals. Current ratings are up to 5 kilowatts per circuit, 115, 230 and 440 volts.

New Capacitor Motors Are Announced

PARTICULARLY designed for use with household refrigerators, compression equipment, pumps, and similar machines, the new capacitor motors of the high torque type introduced by Emerson Electric Mfg. Co., 2018 Washington avenue, St. Louis, give overload capacity in excess of 100 per cent. In designing, the line, air gap tolerances and other precision

Air gap tolerances and other precision refinements have been made smaller than in previous models of capacitor motors

refinements have been made smaller than in previous models. Brushes and commutators are, of course, eliminated by the capacitor design. Resilient spring and rubber base mountings are employed.

Frames are interchangeable for alternating and direct current. Flush bosses on covers permit mounting motors on blower housings. The motors, shown herewith, are available in sizes of 1/8 to 1/3 horsepower with resilient mountings or rigid mountings.

Photoelectric Tubes Are Redesigned

VACUUM type photoelectric tubes having a new order of sensitivity are a recent innovation of General Electric Co., Schenectady,

Photoelectric tube has about the same sensitivity as a gas tube and the stability of a vacuum phototube

N. Y. The tube, shown herewith, is made in an automobile headlamp bulb and is fitted with the standard single contact bayonet type base. Vacuum type tubes usually are characterized by greater stability, and gaseous tubes by higher

WATCH FOR:

Machine Design's Directory

of

Iron, Steel and Nonferrous Alloys

(Third Edition)

This directory lists, by properties, all alloys used in design of machinery. It is being mailed to readers without charge as a supplement to the September issue, but under separate cover. Watch for it!

ALLEN

TRI-MARKT

TRADE MARK

HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um

When you order ALLENS you've *SPECIFIED* every feature you want in Hollow Screws

Chrome-Molybdenum steel, specially heat-treated; HOLDING POWER for any needs; deep, true sockets for perfect wrench-grip; accurate threading to resist loosening in vibrating parts. All these features are brought together—and *bought* together—in Allen screws. *No one* of them would you omit in specifications for dependably-built machines. . . Hand inspection of every screw makes delivery of *uniform quality.* Ask for samples *for test*:—name the sizes you'd like.

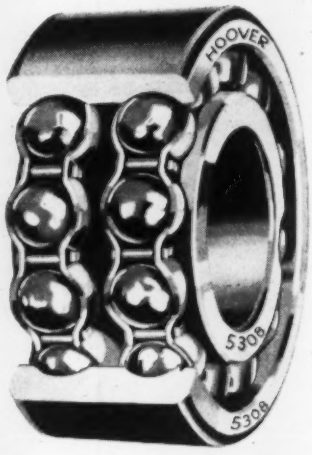
THE ALLEN MFG. COMPANY

HARTFORD, CONN. U.S.A.

sensitivity. The new tube has about the same sensitivity as the usual gas tube and the stability of the usual vacuum phototube.

Introduces Improved Ball Bearing

DOUBLE row annular ball bearings, manufactured according to S. A. E. standards in the light, medium and heavy series, now are being marketed by Hoover Steel Ball Co., Ann Arbor, Mich. These bearings, identified as the 5200, 5300 and 5400 series, are of the deep groove type, having no filling slots or interruption of raceways. This design makes possible a large thrust capacity in either direction in addition to the radial capacity.



Double row annular ball bearings are fabricated from alloy steel

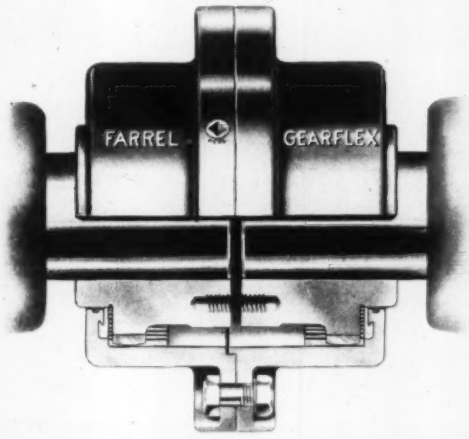
Gears Are Employed in Coupling

FLEXIBLE couplings of the gear type, known as the "Gearflex" coupling, have been introduced by Farrel-Birmingham Co. Inc., 344 Vulcan street, Buffalo, N. Y. The double engagement type, shown herewith, consists essentially of two externally geared hubs keyed to the two shafts to be connected and engaging an internally geared floating sleeve which encases the two hubs. With two sets of spur gears, one at each end of the floating sleeve, misalignment is compensated for by the sleeve assuming a neutral position between the two shafts.

The reservoir between the hubs and the floating sleeve carries the supply of lubricant. When the coupling rotates, centrifugal force throws the oil to the inner surface of the floating sleeve where it spreads between the gear teeth, entirely immersing the load carrying surfaces in a bath of oil. The load is carried by the oil film with no metal-to-metal contact between the

teeth, thus providing a cushioning effect which gives a high degree of quietness in operation and reduces wear.

The coupling also is made in a single engagement type which has only one externally geared



Flexible coupling has large reservoir between the hubs to carry lubricant

hub in engagement with an internal gear in the sleeve, the other hub being solid and the sleeve bolted to it.

Easy Reading Features Thermometer

DEVELOPED especially for equipment manufacturers, the new 5-inch dial indicating thermometer brought out by C. J. Tagliabue Mfg. Co., Park & Nostrand avenues, Brooklyn, N. Y., has an indicating pointer actuated by the motion of a bronze bellows which

Pointer on thermometer designed for easy reading is actuated by motion of a bronze bellows

expands and contracts at each temperature change at the bulb. This motion is transmitted directly to the pointer by a new vibration-proof connecting mechanism.

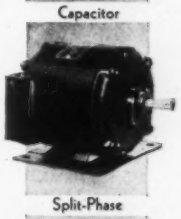
Because of the contrast of the black bakelite

You can Standardize on Wagner Motors

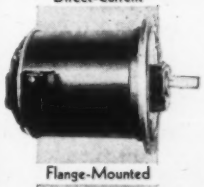
Repulsion-Start-Induction

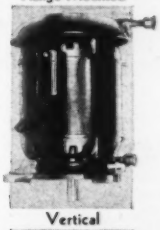
Squirrel-Cage

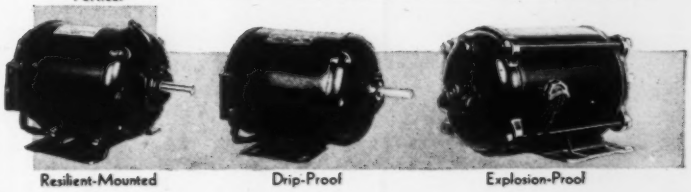
Capacitor


Split-Phase

Direct-Current


Flange-Mounted


Vertical


Resilient-Mounted Drip-Proof Explosion-Proof

The Wagner line includes all types of small motors generally applied on motor-driven machinery, making it possible for you to standardize on Wagner motors. Whether alternating or direct current; single or polyphase; open, drip-proof, totally enclosed or explosion-proof; rigid or resilient-mounted, flange-mounted or built-in; sleeve or ball-bearing; horizontal or vertical—there's a Wagner motor now in existence, ready to be applied on the job.

There are 25,000 different type-horsepower-speed combinations of Wagner motors (in ratings up to 400 hp). Certainly, your motor requirements are no greater than that!

For complete details, ask for Bulletin 167 describing Wagner small motors.

Wagner Electric
MOTORS
TRANSFORMERS
FANS BRAKES

Wagner Electric Corporation
6404 Plymouth Ave., St. Louis, Mo.
Gentlemen;
Please send copy of Bulletin 167 on small motors

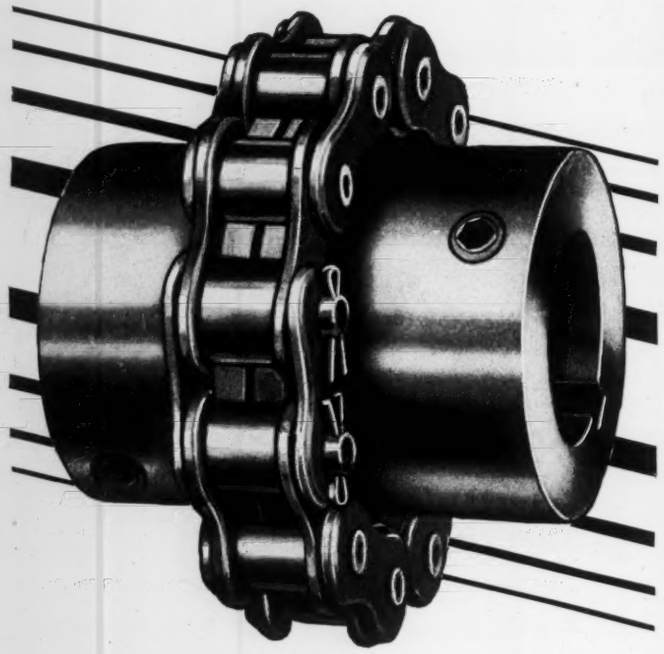
If interested also in large motors, indicate here ☐

Name and Position _____
Firm _____
Address _____ S433-1B

WHITNEY

ROLLER CHAIN

FLEXIBLE COUPLING



The new WHITNEY Roller Chain Flexible Couplings present a number of advantages on direct power drive applications. To the equipment manufacturer they offer a practical and efficient unit which can be depended upon to uphold the performance of his machine. To the machine user they offer quick installation or dismantling of equipment together with unusually long life, due to the use of WHITNEY Roller Chain and accurately cut steel sprockets.

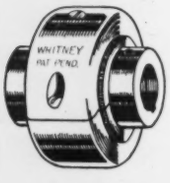
The Rotating Type Coupling Cover has been developed to give improved coupling performance thru proper lubrication, and protection from dirt, grit or other abrasive materials. Its extremely simple and efficient design makes it a real factor in prolonging the life of direct power drives. In addition it gives safety and improved appearance to machines on which it is used.

WRITE FOR BULLETIN V-110

THE WHITNEY MFG. CO.

HARTFORD, CONN.

BOSTON
CLEVELAND
NEW YORK
SAN FRANCISCO

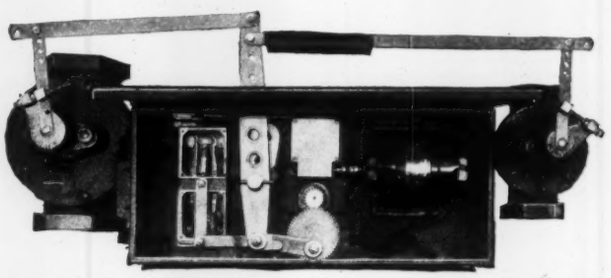


CHICAGO
DETROIT
PHILADELPH'A
SYRACUSE

case with the white numerals on the black dial, this material was chosen. The contrast not only enhances the appearance of the instrument, but it assists in easy reading from a distance.

Controller Utilizes Five Contacts

FIVE separate contacts actuate the instrument with the new type 305 controller recently introduced by Automatic Temperature Control Co., Philadelphia. Two of these are either side of the normal setting which can be obtained through the use of available relays. Through a positive limit switch arrangement each intermediate contact between extreme low and extreme high contact in the actuating instrument has two definite valve positions so that on making one



Controller which has five separate contacts is practically independent of time lag conditions

of these contacts, following a drop in temperature, the valve opening and hence the resultant fuel supply is greater than when the same contact is made following a rise in temperature. With this control system, it is possible to assure a fuel supply more consistent with the fuel demand.

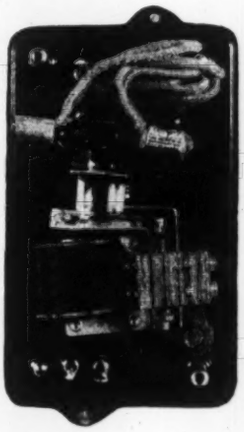
The controller is practically independent of time lag conditions and therefore is able to make the necessary adjustments to keep a furnace within narrow limits of the control setting under changing conditions of time lag. With this controller it is possible to get close control without "hunting" when the valves are set for a much wider operating range than usual.

Special Relays Are Available

FOR the convenience of manufacturers whose equipment embodies electrical relays of all types, the Guardian Electric Mfg. Co., 1522 West Adams street, Chicago, has established a special engineering department to co-operate in the solution of relay design and application problems. A relay that breaks four single-pole double-throw circuits in air and two single-pole double-throw vacuum mercury contact switches, the whole unit making a compact control for

reversing a projector motor and associated apparatus, is shown in the accompanying illustration.

The alternating and direct current relays may

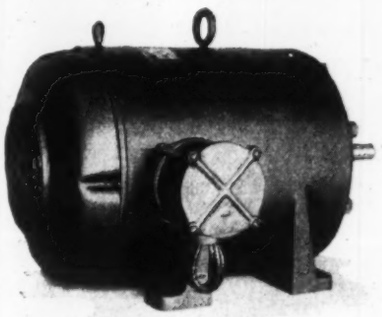


Relay breaks four single-pole double-throw circuits in air and two single-pole double-throw vacuum mercury contact switches

be adapted quickly to the needs of any control circuit. It is the purpose of this new department to assist manufacturers in designs that are especially fitted for the work they are to do.

Develops Dust Tight Motors

TOTALLY enclosed fan cooled motors of dust tight construction and yet of the same size as the ordinary open type motor of the same rating have been developed by Ideal Electric & Mfg. Co., Mansfield, O. As full protection is provided against explosive dust, abrasive dust, corrosive gases or fumes, steam or moisture, the motor is suitable for use in steel mills, metal working

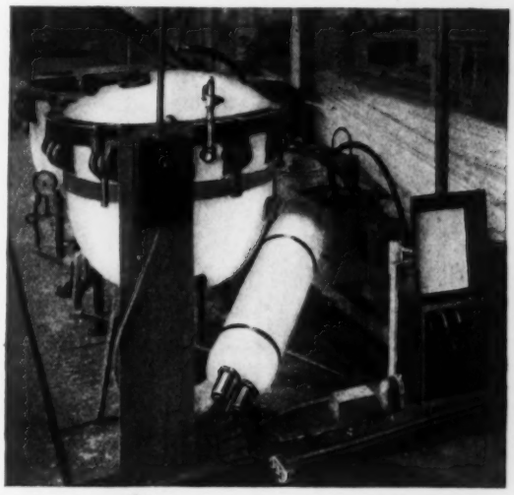


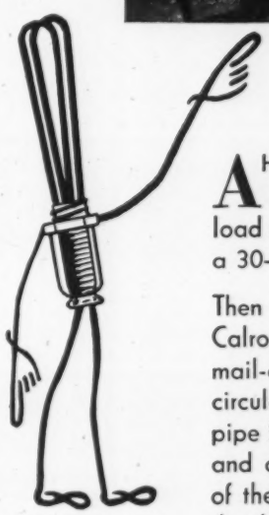
Two shells, the inner one dust tight and enclosing windings and rotor, are employed on new fan cooled motors

plants, foundries, packing plants, chemical plants, laundries, etc.

The construction of the motor, shown herewith, employs two shells, the inner shell being dust tight and enclosing windings and rotor. Tight sealing is obtained by machined metal to metal stationary joints with long close fits. There are no running seals. A fan mounted outside this shell forces a blast of air between the inner shell and the outer one, thereby providing effective cooling.

"Dip" heats this dye kettle and saves $6 a day





"DIP

A HOOKED-RUG manufacturer used to run his steam boiler at reduced load in the summer months just to heat a 30-gal. dye kettle.

Then he read about "Dip," the G-E Calrod liquid-heating unit, in his G-E mail-order catalog. He built a simple circulation heater out of ordinary iron-pipe fittings, using three 5-kw. "Dips," and connected it to the steam jacket of the kettle. Perfect operation and a dandy saving!

"Dip," "Spot," "Strip" and dozens of other midget electric heating units in the G-E Calrod family are described and priced in a convenient mail-order catalog. Write your power company or General Electric Company, Schenectady, N. Y., for a copy.

571-6

GENERAL ELECTRIC

Kindly mail me a free copy of the General Electric mail-order catalog, GEA-1520 on small electric heating units:

Name.....

Firm.....

Street.....

City.....

As Machine Design goes into its fifth year we are naturally proud of the fact that 79% of the companies who contracted for regular space prior to the appearance of the first issue are going along with us.

Franklin H. Johnson
Publisher

Selecting Correct Alloys for Specific Uses

(*Concluded from Page* 31)

ings are made of this steel since they may be heat treated successfully by normalizing.

IX—Steel Castings for Elevated Temperature Service

The nickel-chromium cast steels exhibit excellent creep resistant properties and strength at elevated temperatures. In power plants and oil refineries, where materials capable of withstanding high pressures at elevated temperatures are demanded, a steel of the following composition has come into extensive use: Carbon 0.30 to 0.40 per cent, chromium 0.70 to 0.90, nickel 1.75 to 2.25.

Fig. 4 compares the 1 per cent creep limit stress values of cast carbon and nickel-chromium steels. These curves show the limiting stresses producing not more than 1 per cent of creep in a year. The dotted portion corresponds to the proportional limit. The compositions of these steels are:

	Carbon %	Manganese %	Silicon %	Nickel %	Chromium %
Carbon steel	0.33	0.77	0.34	.....	.....
Nickel-chromium steel	0.41	0.58	0.29	2.00	0.87

Recent investigations have shown that the addition of 0.25 to 0.35 per cent molybdenum to a nickel-chromium steel of about the same composition, as indicated in the foregoing, increases the creep resistance appreciably.

Bibliography

Circular of Bur. of Standards, No. 100, p. 82.

Hoyt, "Metallography—Pt. II, Metals and Common Alloys," p. 308.

Guillett, Traitements Thermiques des Aciers Speciaux," *Revue de Met.*, July, 1910.

Rys, *Kruppsche Monatshefte*, April, 1930, p. 50.

Moffatt, "Effect of Low Temperatures on Impact Resistance of Steel Castings." *Canadian Jnl. of Research*, 1930, p. 327.

Sisco, *Transactions A. S. S. T.*, Feb., 1925, p. 202.

Bullens, *Steel and Its Heat Treatment*, 3d ed., p. 293.

Grotts, "Representative Properties of Cast Medium Pearlitic Steels," and Lorig and Williams, "Physical and Mechanical Properties of Some Well Known Cast Steels," A. F. A.-A. S. T. M. *Symposium on Steel Castings*, 1932.

Korber and Pomp, "Mechanische Eigenschaften von Stahlguss bei Erhohten Temperaturen." *Mittelungen*, Kaiser Wilhelm Institut fur Eisenforschung, 1928, p. 91.

Liestmann and Salzmann, "Uber die Wormfestigkeit von Stahlguss mit geringen Suzatzen von Nickel und Molybdon." *Stahl und Eisen*, 1930, p. 442

Johnson, "Steel Mills Require Rugged Equipment," *Nickel Steel Topics*, Jan., 1933, p. 5.

Hall, "Fe-Mn-Ni-C A New Manganese Steel." *Metal Progress*, Nov., 1931, p. 69.

Kanter and Spring, "Steels Are Now Available for High Pressures and Temperatures." *Power*, May 28, 1929, p. 904.

Bull, "The Performance of Cast Iron and Low Alloy Steels in High and Low Temperature Service." *A. S. T. M.-A. S. M. E. Symposium on Effect of Temperature on Properties of Metals*, 1931.

Malcolm, "Nickel-Chromium Steels for High Temperature Service—Valves and Bolts." *Bulletin No.* 15, *Nickel Steel*, International Nickel Co.

Galibourg, Jean, "Essais de Traction a Chaud sur Aciers (450° C.)." Published in bulletin form for Centre D'Information du Nickel, Paris.

Men of Machines

(*Concluded from Page* 44)

house Electric & Mfg. Co., East Pittsburgh, Pa., to accept a position as professor of mechanical engineering at Columbia university. He intends also to engage in consulting practice.

* * *

Igor I. Sikorsky has been named recipient of the Howard N. Potts medal of the Franklin institute for the development of the multimotored airplane.

* * *

Sir Robert Hadfield, Bt., F. R. S., noted British steelmaker, has had conferred upon him the Decoration of Commendatore of the Order of the Crown of Italy, in recognition of his achievements in metallurgy.

Obituaries

HAROLD D. ARNOLD, director of research, Bell Telephone Laboratories Inc., New York, died recently at Summit, N. J. He was born at Woodstock, Conn., Sept. 3, 1883. Among the researches with which he was concerned, those in the field of electronics are the ones to which his individual contributions were greatest. He had been director of the laboratories since its formation in 1925.

* * *

Alexander Churchward, well-known electrical engineer and former associate of Henry Ford and the late Thomas A. Edison, died recently of a heart attack. For the past 12 years he had been technical director of the Wilson Welding & Metal Co., North Bergen, N. J. He held more than 200 patents in the automotive, radio and telegraphy fields and for many years took an active interest in the Society of Automotive Engineers.

* * *

Frank W. Peek jr., chief engineer of the Pittsfield, Mass., works of the General Electric Co. was killed recently when his auto was struck by a train on the Gaspe peninsula in Canada. Born in California in 1884, he was graduated from Leland Stanford university in 1905. In 1911 he received the degree of master of electrical engineering at Union college. During the early part of his career, Mr. Peek worked under the late Charles P. Steinmetz.

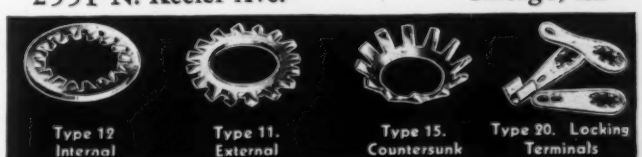
SHAKEPROOF

GIVE YOUR PRODUCT THE "VIBRATION CONTROL" TEST!

IF you would like to know how Shakeproof can improve the performance and lasting satisfaction of your product—make this simple test. First, equip one of your products with Shakeproof Lock Washers and pack it in a shipping case along with another taken from your regular stock. Then, turn these over to your shipping department with instructions to give them plenty of rough handling—just like the treatment they might experience in shipment to a dealer. Next, unpack them and examine each connection—what you see will tell you more about Shakeproof protection and why it cuts down complaints and repair costs than anything we can say. See for yourself—send for testing samples today!

Send today for your free copy of this complete Shakeproof Catalog. Explains thoroughly the many advantages that Shakeproof offers—also shows new patented Shakeproof products.

SHAKEPROOF
Lock Washer Company
(Division of Illinois Tool Works)
2551 N. Keeler Ave. Chicago, Ill.



U. S. Pat. 1,419,564—1,604,122—1,697,954—1,782,387—Other Pat. Pending—Foreign Pat.

The *extra* value of VIKING Pumps

isn't written on the Price Tag

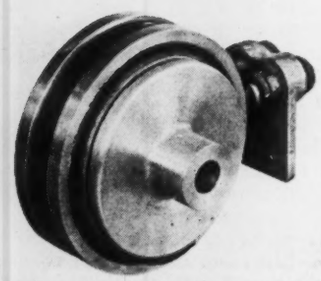
Quality considered, Viking Rotary Pumps cost no more than others. In many instances they actually cost less.

Here are just a few of the EXTRA VALUES of the Viking that aren't written onto the price tag . . . 22 years' experience exclusively devoted to the manufacture of rotary pumps . . . nearly 400,000 Viking Pumps in successful operation today . . . a proven, world-wide record for low power requirements . . . trouble-free service and long life. For extra value . . . use Viking Pumps. Write today for FREE Folder.

VIKING PUMP COMPANY
Cedar Falls, Iowa

Magnetic Clutches

As Small As This



Weight 3½ lbs.

Diameter 3 in.

Torque 40 in. lbs.

15 D.C. Watts to Energize

—are now a standard unit in the Stearns High Duty Magnetic Clutch line, which includes magnetic clutches in virtually all sizes and in single and multiple disc construction for practically any clutch application. Write for descriptive bulletin.

MAGNETIC MFG. COMPANY
651 TL- S. 28th St. Milwaukee, Wis.

HIGH STEARNS DUTY

BEARINGS—Complete information on bearing bronzes suitable for use as a basis for bearing calculations and specifications is included in the "Bearing Metal Data Book" prepared by Federal Mogul Corp., Detroit. The book includes general description and history, definitions of properties, general term definitions, charts of properties and comprehensive descriptions and listing of properties for twelve alloys.

BEARINGS—The application of ball bearings to helical geared speed reducers is discussed in engineering sheet No. 205 FE of New Departure Mfg. Co., Bristol, Conn. This sheet is one of a series published by the company.

CHART INSTRUMENTS—Catalog No. 6702 of Brown Instrument Co., Philadelphia, completely describes the company's new line of thermometers, pressure and vacuum gages and liquid level gages.

CONTROLLERS—Motor operated multiposition controllers which will arrange several valves or regulating devices in from one to six predetermined and adjustable positions are covered in a recent data sheet of Automatic Temperature Control Co. Inc., Philadelphia.

CONTROLS (ELECTRICAL)—American Gas Accumulator Co., Elizabeth, N. J., has issued bulletin N-1 on its Agastat, an electrical time delay relay which can be used in conjunction with any electrical apparatus requiring a time delay.

CONVEYORS—Conveyor chains of silent, roller, Ewart and pintle types for handling glassware, bottles, jars or cans wherever manufactured or filled are covered in folder No. 1365 of Link-Belt Co., Chicago.

COUPLINGS—Whitney Mfg. Co., Hartford, Conn., has prepared bulletin V-110 giving complete data on its new line of roller chain flexible couplings. The couplings consist of two chain sprockets coupled together with roller chain.

DRIVES—Speed, adjustable by infinitely small increments, is provided by the new vari-speed motors developed by Sterling Electric Motors Inc., Los Angeles, and described in a recent bulletin of the company.

DRIVES—General Electric Co., Schenectady, N. Y., has prepared catalog insert GEA-1765 on its line of fractional horsepower gear motors. The drives, for applications requiring speeds lower than those normally obtainable with ordinary motors, are rated at 1/6 to ¾ horsepower with speeds from 500 to 11 revolutions per minute.

FASTENINGS—Parker-Kalon Corp., New York, has prepared a folder on its new line of thumb screws, cold forged by a new process from one piece. The fastenings take a good plated finish.

MOTORS—Wagner Electric Corp., St. Louis, has prepared a loose leaf bulletin sheet on three types of vertical motors which also explains how horizontal type motors may be mounted vertically.

MOTORS—Totally enclosed fan cooled motors protected against dust of all types, fumes and moisture are described in literature prepared by Ideal Electric & Mfg. Co., Mansfield, Ohio.

MOTORS—Type G high speed synchronous motors recommended for all types of constant speed machinery are discussed in leaflet 20537 of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Another leaflet of the company, No. 20580, covers type FH resistance split phase motors suggested for applications such as oil burners, fans and blowers, centrifugal pumps, small woodworking tools and other industrial and domestic machines.

THERMOMETERS—Dial indicating thermometers intended for incorporation in machines are announced in a bulletin of C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. The instruments provide exceptional visibility of values at some distance from the machine. The bulletin is listed as No. 1050 by the company.

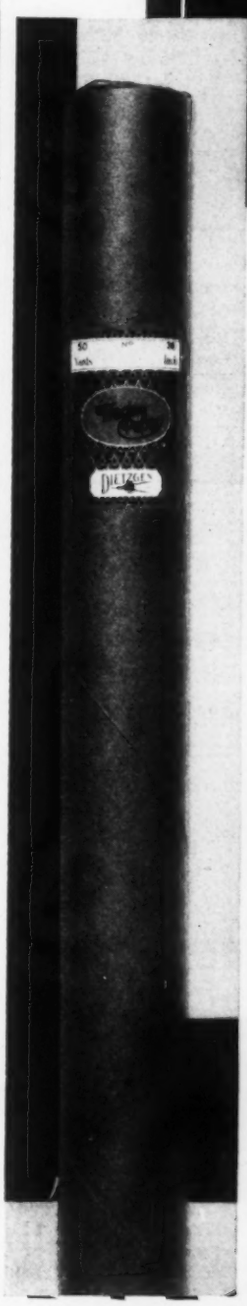
VALVES—Catalog No. 23 of Jenkins Bros., New York, includes complete details on 400 valves in a wide range of types and patterns and gives full information about the metals used in making the valves. Services, pressures, temperatures and fluids for which the valves are recommended are stated. The last section of the 264-page book contains many pages of engineering data that is needed where valves are specified.

WELDED PARTS AND EQUIPMENT—The place of shape cutting in industry is covered in an article in the August issue of *Oxy-Acetylene Tips*, published by Linde Air Products Co., New York.

Research Publications

A Popular Fallacy About Motor Oils, by James I. Clower A summary of the results of three surveys on lubricating oils carried out by New York university's bureau of business research to determine whether or not any particular source of crude is essential to the production of high grade lubricants. Published in *Technical Topics* of Virginia Polytechnic Institute, Blacksburg, Va.

Initial Stresses in Large Forgings, by Dr. Ing. G. Kirchberg. There is hardly a category of stresses which is so difficult to determine as the initial stresses. The designer, therefore, has been reduced to the necessity of estimating their magnitude, especially in pieces of larger size. More exact information now is afforded by the present research account which investigates and determines the initial stresses in two forgings of cylindrical shape. Published in German by VDI-Verlag G. m.b.H., Berlin, Germany. 29 pp. 5 marks.



ADAPTABILITY

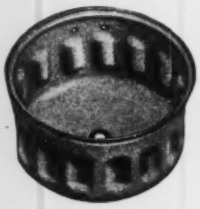
The world regards the works of the ancient Greeks as the epitome in culture. Their adaptability and individuality as characterized in the ceremonial vase have given us the inspiration for grace, beauty of design, and shapeliness of outline ››› The modern artist, be he architect, engineer, draftsman or student ... will better interpret his own ideas of beauty and practicability if he too will individualize his efforts ››› How better to begin than at the beginning ... in your tracings? The "tooth", transparency, glaze, thickness, and strength of the paper ... the hardness of your favorite pencil, kind of ink, style of pen, pressure of your hand, all affect the results. And in the many different tracing papers, vellums, and cloths individualized by DIETZGEN surely there is one to fit YOU.

- Send for samples ... and select
- for yourself the papers which
- help you to interpret your ideas
- most easily. There is no cost or
- obligation and you will be amazed
- at the difference in results.

DIETZGEN

Eugene Dietzgen Co., Manufacturers of Drafting and Surveying Supplies
Chicago New York New Orleans Pittsburgh
San Francisco Milwaukee Los Angeles Philadelphia Washington
Factory at Chicago

This G. P. & F. stamped base replaced casting at big saving.



Fluted steel tub drawn and porcelain-enameled by G. P. & F.

Stainless Steel Shell Drawn and Welded by G. P. & F.

Save Money With G. P. & F. Stampings

If you use pressed metal parts of any kind—let us suggest possible improvements.

If you haven't used stampings, let us have drawings or samples of castings or parts that you think might be redesigned in pressed metal. A suggestion may save you many thousands per year — add strength and beauty to your product.

If you are working on new products in your drafting room—let us show you ways to cut costs and get into production quicker. G.P.&F. die estimates are accurate—over 50 years of experience under the same management.

Ask for booklet *"In Harmony with Modern Progress"*.

GEUDER, PAESCHKE & FREY CO.

Sales Representatives in Principal Cities in All Parts of the Country

1417 W. St. Paul Ave., Milwaukee, Wis.

364 W. Ohio St., Chicago, Ill.

G.P.&F. STAMPINGS

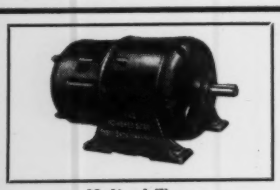
MACHINE DESIGN is a monthly technical publication conceived, edited and directed expressly for executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of materials and parts to be used.

*

INDEX TO ADVERTISERS

Ajax Flexible Coupling Co.	*
Alemite Corp.	6
Allen Mfg. Co.	56
Baldwin-Duckworth Chain Corp.	*
Belden Manufacturing Co.	*
Bristol Co.	65
Century Electric Co.	10
Chicago Rawhide Mfg. Co.	*
Cutler-Hammer, Inc.	Outside Back Cover
Diamond Chain & Mfg. Co.	*
Dietzgen, Eugene, Co.	63
Electro Metallurgical Sales Corp.	*
Fafnir Bearing Co.	4
Fairbanks, Morse & Co.	66
Garlock Packing Co.	*
General Electric Co.	49, 59
Geuder, Paeschke & Frey Co.	64
Haynes Stellite Co.	9
Hyatt Roller Bearing Co.	47
Illinois Steel Co.	Inside Front Cover
International Nickel Co.	53
Leland Electric Co.	*
Lewellen Mfg. Co.	*
Lincoln Electric Co.	*
Link-Belt Co.	3
Magnetic Mfg. Co.	62
New Departure Mfg. Co., The	*
New Jersey Zinc Co.	Inside Back Cover
Norma-Hoffmann Bearings Corp.	54
Reeves Pulley Co.	*
Roper, Geo. D., Corp.	*
Shakeproof Lock Washer Co.	61
S. K. F. Industries, Inc.	51
Timken Roller Bearing Co.	*
Union Carbide and Carbon Corp.	9
Viking Pump Co.	62
Wagner Electric Corp.	57
White, S. S., Dental Mfg. Co.	*
Whitney Mfg. Co.	58

*Advertisements appear in previous issues.



Helical Type Powered Gear

Radiating Worm Type Powered Gear

IXL POWERED-GEARS

IXL POWERED GEARS (Motorized Speed Reducers) recently added to our present complete line of speed reducers and cut gear products are the result of many months of intensive study and research by our Engineering Staff, and are backed by seventy-five years of specialized experience in the power transmission field.

IXL POWERED GEARS are made in Helical Gear and "Radiating" Worm Gear types, either horizontal or vertical, in straight through or offset parallel and right angle drives. Either type can be supplied in a complete range of ratios and sizes from fractional H.P. to 75 H.P. capacities.

Send in your general specifications and recommendations and our Engineering Dept. will select the proper size and type of POWERED GEAR unit to meet your requirements. Your copy of the IXL POWERED GEAR bulletin fully illustrating and describing these motorized speed reducers will be sent on request.

FOOTE BROS. GEAR & MACHINE CO.

5303 So. Western Blvd. Chicago, Ill.

Branch Offices in all the Principal Cities of U.S.A. and Canada

Business and Sales Briefs

LUKENWELD INC., division of Lukens Steel Co., Coatesville, Pa., has been awarded the contract by Winton Engine Corp., Cleveland, for the manufacture, in arc welded rolled steel construction, of the complete engine structure for the 600 horsepower engine which will power the new 110-mile an hour light weight passenger train of the Union Pacific system.

* * *

General Electric Co., Schenectady, N. Y., and four of its associated companies have removed their New York city offices to the new General Electric building, 570 Lexington avenue, at Fifty-first street.

* * *

Machinery and Allied Products institute, recently formed, has opened an office at 2 West Forty-fifth street, New York, in charge of M. J. Reed. John W. O'Leary, Chicago, is head of the organization.

* * *

E. J. Murray has been appointed Chicago district sales manager for the Highland Iron & Steel Co., Terre Haute, Ind., subsidiary of American Chain Co., Bridgeport, Conn.

* * *

Lunkenheimer Co. has moved its Boston branch to 291-293 Congress street.

* * *

Alemite Corp., Chicago, has been awarded a decision in a patent case which gives them complete freedom to engage in the field of centralized lubrication for automobiles and industrial machinery.

* * *

Hendy A. Getty has been appointed New England representative for Alan Wood Steel Co., Conshohocken, Pa., with headquarters at 250 Stuart street, Consolidated Gas building, Boston.

* * *

H. E. Ewart, formerly assistant chief engineer of United Engineering & Foundry Co., is now representing Bantam Ball Bearing Co., South Bend, Ind., in the Pittsburgh district on steel mill and industrial bearing applications. Mr. Ewart's address is at present Coraopolis, Pa.

* * *

General Electric Co., Schenectady, N. Y., and its subsidiary companies in the United States have been licensed by Dardelet Threadlock Corp., New York, to manufacture for their own use bolts, nuts and other parts threaded with self-locking screw thread.

* * *

Leo I. Smith, 45 Gorham road, Belmont, Mass., has been appointed district representative for the New England territory by Roots-Connersville-Wilbraham, Connersville, Inc., manufacturer of blowers, gas exhausters and meters, liquid and vacuum pumps, inert gas machines, etc.

* * *

Drew Service Corp., 220 West Forty-second street, New York, has established a central bureau which is to analyze new processes, designs and inventions in the most important fields of manufacture and to supply to manufacturers classified information on new items recently patented, and still unmarketed, with an investigation and an analysis of any in which a member might be interested. The organization will not solicit the sale of any patent or new development, but merely submit it to keep the manufacturer informed of the latest development in the field.

The difference *is in the* Socket...

BRISTO Safety Set Screw, Socket Head Cap Screw, and Wrench. Dovetailed flutes on wrench interlock with those in socket, providing a firm grip that makes a tight set.

EVERYTHING DEPENDS on the design of socket employed in hollow screws. Here is where the power exerted by your arm is transmitted to the point of the screw. Here, too, is where wear and abuse come. Accordingly the life of hollow safety set and cap screws depends upon the life of the socket.

The dovetails in the BRISTO socket guide the force applied by the wrench around in the direction in which the screw turns, without straining the sides of the screw.

For many years, now, BRISTO screws have been made in several extra small sizes, all smaller than ¼ inch. This fact is convincing proof of the effectiveness of the socket design. These extra small sizes are an exclusive BRISTO feature.

BRISTO screws are made for the hardest job in the plant. They set up easily, hold tight, wear long, yet cost no more than other hollow safety set screws.

BRISTO Safety Cap Screws, Set Screws and Wrenches are guaranteed to be made of carefully selected steel, and will be replaced without charge upon evidence showing defective material and workmanship.

We also make BRISTOL'S Steel Belt Lacing. Send for samples.

Write for samples.

THE BRISTOL COMPANY, WATERBURY, CONN.

Branch Offices: Akron, Birmingham, Boston, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco

NRA MEMBER U.S. WE DO OUR PART

TRADE MARK

BRISTO

REG. U.S. PAT. OFF.

Hollow Safety **SET SCREWS** *Socket Head* **CAP SCREWS**

Engineering
Library

Directory of

IRON, STEEL

and

NONFERROUS ALLOYS

Used in Design of Machines

Third Edition

Published as a Supplement to

September, 1933, Issue

THIS third edition of MACHINE DESIGN'S *Alloy Supplement is a complete revision of earlier editions. It has been brought up-to-date through the co-operation of producers of alloys, for the assistance of machine designers in the selection of materials for their use.*

TO MAKE the directory more valuable for reference purposes, alloys have been classified by properties. Numbers signifying these properties appear immediately above each listing and the key is printed at the foot of all pages; other less common properties are given in the text matter. The alloys also are listed alphabetically by trade name.

ADDITIONS to the list will be announced periodically in MACHINE DESIGN. *It is suggested that information on these new materials be added to their respective alphabetical groups, using the blank spaces provided in the directory for this purpose.*

Twenty-Five Cents

Directory of Alloys Used in Design of Machines

A

1 - - - - - - - - - -

ACME; "18" stainless; carbon under .12, manganese under .50, silicon under .50 chromium 11.5 to 14, phosphorus .025 max., sulphur .025 max. "RA" stainless; carbon .10 max., manganese .40, chromium 16, silicon 1, copper 1, phosphorus and sulphur .03. "18-8" stainless; carbon under .16, manganese under .50, silicon .50, chromium 17 to 20, nickel 7 to 10, phosphorus .025 max., sulphur .025 max. Acme Steel Co., Chicago.

1 - - - - - - - - - -

ADMIRALTY BRONZE; copper 70, tin 1, zinc 29, standard alloy for condenser tubes, particularly for salt or brackish water. Chase Brass & Copper Co. Inc., Waterbury, Conn. Conn.

1 - - 4 5 - - - - 10

ADNIC, corrosion resistance is major property, others include high malleablity; copper 70, tin 1, and nickel 29 per cent; sheet wire and rod. Scovill Mfg. Co., Waterbury, Conn.

- - - - - - - 7 - - 10

ADVANCE; for electrical use primarily, nonmagnetic; copper 54, nickel 46; thermocouple material for applications where low temperature coefficient of resistivity is required: measuring instruments, precision equipment, industrial and radio rheostats, and elevator controls. Driver-Harris Co., Harrison, N. J.

- - 3 - - - - - - 10

AGATHON; general brand name for alloy steel for resistance to wear, shock, stress and strain. Republic Steel Corp., Youngstown, O.

1 - - - - - - 7 - 9 -

ALCOA; light weight aluminum alloys for sand, die and permanent mold castings, plate, sheet, foil, bar, rod, wire, tubing, structural shapes, moldings, forgings and stampings; numerous grades with varying compositions to meet such specific requirements as corrosion resistance, good electrical and thermal conductivities, high strength-weight ratio, etc. Aluminum Co. of America, Pittsburgh.

1 - - - - - - 7 - - -

ALCUMITE; copper 90, aluminum 9, iron 1; for pumps, valves, pipe, fittings, bars and castings for corrosive service where a copper base allay is preferred. Duriron Co. Inc., Dayton, O.

1 2 - 4 5 - - - - - -

ALCUNIC; corrosion resistance is major property; copper 70, nickel 1, aluminum 2 and zinc 27 per cent; condenser tubing, wire, rod, sheet. Scovill Mfg. Co., Waterbury, Conn.

1 2 - - 5 - - 8 - 10

ALLEGHENY METAL; resists corrosion; carbon .05 to 1, manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 16 to 20, nickel 7 to 10; used for dairy equipment, pulp and paper

machinery, domestic machines, laundry machine parts, etc. Allegheny—33; corrosion resisting chromium steel alloy; carbon under .12, manganese under .50, phosphorus under .025, sulphur under .025, silicon under .50, chromium 12 to 15; resists temperatures up to 1500 degrees Fahr. Grade 44; readily fabricated and resists high temperatures; carbon under .20, manganese under 1.25, sulphur under .025, phosphorus under .025, silicon under .50, chromium 20 to 30, nickel 10 to 20; malleable and ductile and is machined easily; for pump parts, etc. Grade 46; low-alloy, heat and corrosion resisting steel; carbon .12 to .20, manganese .50 max., phosphorus .04 max., sulphur .04 max., silicon .50 max., chromium 4 to 6, molybdenum .4 to .6, tungsten 1 to 1.25, aluminum .5 to 1, copper .5 to 1; for dampers, pumps, valves, etc. Grade 55; chromium iron alloy for high temperature service up to 2150 degrees Fahr.; carbon under .25, manganese under 1, sulphur under .025, phosphorus under .025 silicon under .50, chromium 26 to 30; machinable in softened condition, for furnace parts, etc. Grade 66; chemical resisting chromium steel; carbon .12, manganese .31, silicon .216, chromium 17.66, nickel .24; analysis for upper chromium limit; for nitric acid, steam engine parts, etc. Allegheny Steel Co., Brackenridge, Pa.

1 2 - 4 5 - - - - -

AMBRAC; grade A; copper 75, zinc 5, nickel 20. B, copper 65, zinc 5, nickel 30. B has better corrosion resisting properties than A because of the higher nickel content. Grade A is for tubes for condensers and heat exchangers, etc. American Brass Co., Waterbury, Conn.

1 2 3 4 5 - - 8 - -

AMERICAN; stainless steel, chromium 8 to 60, carbon over .12, balance mostly iron; for oil, textile, pumping machinery, and other equipment requiring a corrosion resistant (primary property), tough, hard, high strength heat treated alloy. Stainless iron, chromium 8 to 60 per cent, carbon .12 per cent or under, balance mostly iron; for oil, dairy, laundry, textile, paper, refrigerating equipment etc. where a corrosion resistant, ductile, heat and abrasion resistant alloy is required. American Stainless Steel Co., Pittsburgh.

1 - - 4 5 6 - - - -

AMPCO METAL; No. 16; copper 87.30, iron 3.40, aluminum 9.15. No. 18; copper 86.50, iron 3.75, aluminum 9.50. No. 20; copper 85.50, iron 4.25 aluminum 10.00 per cent. No. 21; copper 82.50, iron 5.25, aluminum 12.00; for forming dies, welding jaws, bushings, gears, pickling equipment, nonfatiguing parts, etc. Ampco Metal Inc., Milwaukee.

1 2 3 4 5 - - 8 - 10

AMSCO; six grades of alloys, particularly heat resistant; also resistant to acid and corrosive substances, as well as abrasion resistant and suited to heat treatment. Grade F-1; chromium 16 to 29, nickel 35 to 38. F-2; chromium 26 to 29, nickel 0 to 3. F-3; chromium 26 to 29, nickel 0 to 3, high carbon. F-5; chromium 18 to 21, nickel 62 to 65. F-8; chromium 18 to 21, nickel 8 to 11. F-10; chromium 26 to 29, nickel 10 to 13. For heat treating furnaces, ore roasting furnaces, paper mill machinery and cement mill machinery. Manganese steel castings; manganese 10 to 14, carbon 1 to 1.40; primarily abrasion resistant; also resistant to shock; high tensile strength and ductility; for power shovel dippers, teeth, crawler shoes, crusher mantles, jaws, dredge pumps, and wearing parts for excavating, and other types of equipment. American Manganese Steel Co., Inc., Chicago Heights, Ill.

1 2 3 4 - 6 7 8 - -

ANACONDA; beryllium copper, copper 97.75, beryllium 2.25 per cent; for springs, diaphragms, low duty bushings and bearings and Bourdon tubes, also parts requiring high resistance to fatigue. American Brass Co., Waterbury, Conn.

1 - - - - - - - - - -

APOLLOY METAL; resistant to corrosion; carbon .08, manganese .40, sulphur .025, phosphorus under .045 and copper .25 per cent. Apollo Steel Co., Apollo, Pa.

- - - - - - - 7 - - 10

ARMCO; Tran-Cor 64; high silicon steel for distribution transformers. Tran-Cor 70; high silicon steel sheets with low core loss; for power and distribution transformers. Tran-Cor 76; high silicon steel for general transformer work and large generators. Intermediate Transformer; a scale free silicon steel sheet for some transformers and special applications; Armco Special Electric; a scale-free medium steel sheet for a.c. motors and generators. Armco Electric; a special analysis sheet for rotating machines. Armature; steel sheet for small d.c. motors. Radio No. 6; for applications in which superior low induction magnetic characteristics are important. Radio No. 5; for audio transformer cores and other low induction applications. Radio No. 4; good permeability at low induction; for chokes. Radio Nos. 3, 2, 1; for small transformers. Armco ingot iron; highly refined iron for magnetic cores; supplied in round and flat bar form. American Rolling Mill Co., Middletown, O.

- - 3 4 - - - 8 - -

ATLAS; No. 93, grade 38; chromium .65, molybdenum .35; for collets, studs and parts requiring toughness in hardened condition. Ludlum Steel Co., Watervliet, N. Y.

Additions to listings:

B

1 2 - - - - - - - - 10

B & W; Alloy 5; chromium molybdenum; oxidation resistant; 4 to 6 per cent chromium for oil refinery service. No. 5; also 4 to 6 per cent chromium; for oil refinery service; similar properties. Alloy 18-8 low carbon; resistant to corrosion, heat, scale and creep. Alloy 18 is 18 per cent chromium steel for high temperature work if no long heating is involved. Alloy 18-8; resistant to scale, corrosion, heat; general purpose alloy for use similar to alloy 18-8 low carbon, except that for pressure service the temperature should not exceed 600 degrees Fahr. Babcock & Wilcox Tube Co., New York.

1 2 - - - - 7 - - -

BAKER; platinum and alloys; for linings, contacts, themocouples, furnace resistors, etc. Baker & Co. Inc., Newark, N. J.

1 - - - - - - - - - -

BARBERITE; alloy made up of 88.5 per cent copper, 5 nickel, 5 tin and 1.5 per cent silicon; for applications where dilute sulphuric acid concentrations are below 60 degrees Be' and temperature below 96 degrees Cent. Barber Asphalt Co., Philadelphia.

1 - - - - 6 - - - 10

BEARIUM METAL; in addition to heat resistance has low coefficient of friction; composed of copper, tin, lead combined by special process and supplied in several grades and analyses to meet specific operating conditions. Bearium Metals Corp., Rochester, N. Y.

1 2 - - - - - - - - -

BETHADOUR; corrosion and heat resisting steels for virtually all purposes except those calling for free machining. Bethlehem Steel Co., Bethlehem, Pa.

1 - - - - - - - - - 10

BETHALON; free machining, nonrusting, high chromium steel for a variety of machine parts. Bethlehem Steel Co., Bethlehem, Pa.

1 - - 4 - - - - - - -

BIRDSBORO; No. 26 has high physical properties including high tensile strength. No. 30; corrosion and fatigue resisting. Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

- - 3 - - - - - - - -

BLACKOR; for use where resistance to abrasion is primary consideration; tungsten carbide specially processed for electrical arc welding application; for oil well tools, grading and agricultural machinery, coal mining equipment, airplane skid shoes, etc. Blackor Co., Los Angeles, Calif.

- - - - - - - - - 9 -

BOHNALITE; a light alloy of which aluminum is the base; for forged connecting rods, cast cylinder heads, crank cases, transmission cases, bearing caps, vacuum cleaners, washing machines, shoe machinery, etc. Bohn Aluminum & Brass Corp., Detroit.

- - 3 4 5 - - - - - -

BONNEY-FLOYD; MM alloy steel, manganese, molybdenum, and .25 to .35 carbon; cast steel with high physical properties for general purposes. Quenched, tempered low carbon steel; carbon .25 to .35, manganese .7 to .90, silicon .40 max., sulphur and phosphorus .05 maximum; general steel casting requirements where high strength and shock resistance are required. NCM alloy steel; nickel, chrome, molybdenum, carbon .25 to .35, for bucket lips, bucket teeth, dragline clevises and other uses where abrasion is encountered in the design of machines and equipment. Bonney-Floyd Co., Columbus, O.

- - - - - - 6 - - - -

BUNTING; a line of some one hundred and sixty odd bearing bronzes to any desired specification, sand or chill cast; for sleeve bearings etc. friction rings and special applications. Bunting Brass & Bronze Co., Toledo, O.

Additions to listings:

C

1 2 - 4 5 - - - - 10

CALITE; "A", a nickel-chromium-iron alloy available in the form of castings and rolled bar stock; readily machinable. Type "B"; cast form only for oil refining industry. "B-28"; available as castings, sheet and bar stock; possesses extreme stiffness at all temperatures and is corrosion resistant. "N"; nickel-chromium-iron in sheets, bars, castings. "S"; malleable alloy steel, greatest utility in form of hot rolled sheets for corrosion work at moderate temperature; may be flanged, punched or assembled by welding. "E"; a malleable alloy steel in form of bars and sheets; not affected by weather corrosion, sulphur compounds and many organic acids and inorganic salts. Also Calite-Nirosta stainless steels in cast form. The Calorizing Co., Pittsburgh.

- 2 3 4 - 6 - - - -

CANNONITE; electric furnace high test cast iron; total carbon 2.75 to 3 per cent; for diesel and automobile cylinders, centrifugal sleeves and brake drums, gas tight castings, presses, dies, etc. Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich.

1 2 3 4 5 6 7 8 - 10

CARPENTER: stainless steel, No. 1; corrosion, heat resistant, high tensile strength; carbon .10, chromium 12 to 15; for stampings, turbine blades, pump shafts and many heat treated parts. No. 2; corrosion, abrasion resistant, high tensile strength; carbon .30, chromium 13; used in fully hardened condition for tapes, ball bearings, ball check valves, etc. 2-B; corrosion, abrasion resistant, high tensile strength; carbon .95, chromium 17; for ball bearings, ball check valves, etc. No. 3; corrosion, heat resistant; carbon .3, chromium 20, copper 1, for special chemical apparatus and scale resisting parts. No. 4; corrosion, heat resistant, high ductility; carbon .10, chromium 18, nickel 9. No. 5; heat, corrosion, abrasion resistant, high tensile strength; carbon .10, chromium 14, sulphur .30; a free machining grade for parts made on automatic screw machines or machined from forgings. No. 6; corrosion resistant; carbon .10, chromium 17. No. 8; corrosion, heat, abrasion resistant, high ductility, electrical uses; carbon .10, chromium 18, nickel 9, selenium .25; a free machining grade. No. 5-317 chrome-nickel steel; abrasion resistant, high tensile strength; carbon .50, nickel 1.75, chromium 1; used for gears, clutches and shafts. No. 4-408; abrasion resistant, high tensile strength; carbon .40, nickel 3, chromium .75; for clutches and shafts. No. 158; abrasion resistant, high tensile strength and ductility; carbon .10, nickel 3.50, chromium 1.50; for case hardened high duty clash gears, shafts, clutch parts. No. 4 Samson steel; abrasion resistant, high tensile strength; carbon .40, nickel 1.25, chromium .60; for shanks of high speed tools, side links of silent chains, etc. No. 2; abrasion resistant, high ductility, carbon .20, nickel 1.25, chromium .60; used for gears, roller bearings, pneumatic tool parts, etc. N-30 steel; 30 per cent nickel; for electrical parts, nonmagnetic, special thermal expansion properties. No. 3-547 nickel steel; abrasion resistant and high strength; carbon .30, nickel 3.50; for heat treated shafts, etc. No. 547 case hardening nickel steel; abrasion resistant, high ductility; carbon .20, nickel 3.50; for small parts requiring hard surface and tough core. No. 500; carbon .10, nickel 5; for turbine blades, case hardened gears, etc. Chrome magnet steel; carbon .95, chromium 3.50; for magnets in meters and other electrical apparatus. Presto steel; carbon 1.05, chromium 1.40; for ball and roller bearings. Chrome vanadium 5-720; carbon .50, chromium .90, vanadium .20; for leaf and coil springs, gears, shafts, etc. No. 3-427 chrome molybdenum steel; abrasion resistant, high tensile strength; carbon .30, chromium 1, molybdenum .20; for aircraft and automotive parts. No. 436; abrasion resistant, high ductility; carbon .15, nickel 1.75; molybdenum .25; for case hardened parts. Silico-manganese steel; carbon .60, manganese .75, silicon 2; for heavy-duty springs. Carpenter Steel Co., Reading, Pa.

- - 3 - - - - - - - -

CASTALOY; air hardening tool steel castings; chromium 12 to 14 and carbon 1.5 to 1.6 per cent. Detroit Alloy Steel Co., Detroit.

1 - - - - - - - - - -

CATARACT METAL; corrosion resisting, nickel copper for introduction into alloy casting metal. Niagara Falls Smelting & Refining Corp., Buffalo.

1 - - 4 5 - - - - -

CHAMET BRONZE; principally corrosion resistant; copper 60, tin .75.

zinc 39.25; for general use where strong corrosion resistant brass is required. Chase Brass & Copper Co. Inc., Waterbury, Conn.

1 - - 4 5 6 - - - -

CHASE; free-turning bearing bronze; copper 88, lead 4, tin 4, zinc 4; for automotive and other bearings; also automatic screw machine parts requiring good physical properties and high corrosion resistance. Nickel aluminum bronze; principally corrosion resistant; copper 92, nickel 4, aluminum 4; for use where combination of good physical properties and corrosion resistance is desired; particularly recommended for condenser tubes in oil refineries or where temperatures are not higher than in the usual surface condensers. Chase Brass & Copper Co. Inc., Waterbury, Conn.

- 2 - - - - - - - - -

CHRISTITE No. 1; heat-resisting alloy; tungsten 17, chromium 10 and molybdenum 2.5 per cent. Commercial Alloys Co., San Francisco, Calif.

1 2 - - - - - 8 - -

CHROMAX; cast; nickel 35, chromium 15 per cent; for furnace parts, carburizing containers, enameling racks and fixtures, conveyor chains, etc. Driver-Harris Co., Harrison, N. J.

- 2 - - - - - - - -

CHROMEL; No. 502 is heat resistant; 18 to 22 per cent chromium, 30 to 34 nickel, balance mainly iron; for burning tools in the enameling industry and for metal furnace parts. Grade A; heat resistant; 80 nickel, 20 chromium; used for electric heating elements. Hoskins Mfg. Co., Detroit.

- - 3 - - - - - - -

CHROMONITE; hard alloy chill roll made in three grades, mild, medium, and hard; for special applications. Continental Roll & Steel Foundry Co., East Chicago, Ind.

1 2 3 - - - - - - -

CIMET; cast, particularly corrosion resistant; nickel 10, chromium 7; for furnace parts in high sulphur atmospheres, acid resisting castings such as impellers, pumps, piping, etc.; stainless casting. Driver-Harris Co., Harrison, N. J.

1 2 3 4 5 - 7 8 9 -

CIRCLE L; No. 1; high strength and ductility castings; medium manganese, carbon .30 to .40. No. 2; high tensile strength and ductility; carbon .30 to .40, chromium 1, molybdenum .30; for crankshafts, rocker arms, airplane parts, etc. No. 3; abrasion resistant, high tensile strength and ductility; carbon .40 to .50, chromium 1.25, molybdenum .40; for gears, cams, digger and dredge teeth. No. 4; abrasion resistant, high tensile strength; carbon .50 to .80, chromium 1.25 to 2.00, molybdenum .50 to 1; for cams, crusher jaws, etc. No. 6; case hardening alloy, abrasion resistant, high tensile strength and ductility; carbon .18, nickel 1.75, molybdenum .25; for parts carburized and hardened. No. 8; nitriding steel, abrasion resistant, high tensile strength; carbon .25, chromium 1.50, vanadium .50. No. 10; high tensile strength and ductility; carbon .20, chromium 5, molybdenum .50; for high pressure and high temperature applications in the oil industry. No. 11; carbon .25, chromium 17 to 20, copper 1; for parts subjected to heat and corrosion. No. 12; corrosion resistant, high tensile strength and ductility; carbon .10, chromium 13, nickel .50 max.; for valves, fittings and pumps in the oil industry. No. 15; heat and corrosion resistant; carbon .30, chromium 28.50, nickel .50 max.; nitric acid resisting. No. 22; heat and corrosion resistant, high tensile strength and ductility, low specific gravity; carbon .07 max., chromium 17 to 20, nickel 8 to 10; for severe corrosive conditions and for parts fabricated by welding. No. 23; heat, corrosion resistant, high tensile strength and ductility, electrical uses; carbon .15, chromium 17 to 20, nickel 8 to 10;

hydrogen sulphide, mild sulphuric acid and other corrosive applications. No. 24; corrosion resistant, high tensile strength and ductility; carbon .15, chromium 8 to 10, nickel 17 to 20. No. 25; corrosion, heat resistant, low specific gravity high tensile strength and ductility; carbon .15, chromium 20 min., nickel 9; for valves and pump parts for the paper industry. No. 30; properties and uses same as No. 25; contains .15 carbon, 25 chromium, 10 nickel. No. 31; properties also similar to No. 25 with addition of heat treating; carbon .25, chromium 28, nickel 11; resistant to oxidation at high temperatures. No. 32; heat, corrosion resistant, high tensile strength and low specific gravity; carbon .50, chromium 16, nickel 35; good resistance to sulphuric acid. Lebanon Steel Foundry, Lebanon, Pa.

- - - - - **6** - - - -

CLOVERLEAF; babbitt metal; for bushings, bearings. E. A. Williams & Son Inc., Jersey City, N. J.

- - **3** - - - - - - - -

CNM; chrome nickel alloy possessing wear resisting qualities. George H. Smith Steel Casting Co., Milwaukee.

- - - - - - - - - - **10**

COBALTCROM "PRK 33"; a nondeforming, air hardening steel; chromium 12 to 14, cobalt .7 to .9 and carbon 1.5 to 1.6 per cent. Detroit Alloy Steel Co., Detroit.

- - - - - - - **7** - - -

COMET; nickel 31, chromium 2, balance iron; for heavy duty rheostats, elevator and crane controllers. Driver-Harris Co., Harrison, N. J.

- - - - - **6** - - - -

COMMERCIAL; for bearings, bushings and bars; copper 83, tin 7, zinc 7 and lead 3 per cent. Buckeye Brass & Mfg. Co., Cleveland.

- - - - - - **6** - - - -

COMPO; strong, die-pressed porous bearing bronze; made of powdered metals by patented process; for self-lubricating bearings used in the automotive industry, household appliances, textile machines, etc. Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

1 - - - - - - - - - - -

CORROSOIRON; an acid resisting iron; silicon 13.50, iron 85.5 per cent. Pacific Foundry Co., San Francisco, Calif.

- - **3** - - - - - - - - -

CROCAR; carbon 2.20, chromium 12.00 per cent; for parts to resist excessive wear. Vanadium-Alloy Steel Co., Latrobe, Pa.

- - - **4 5 6** - **8** - -

CROMANSIL; high tensile strength and ductility; chrome .50, manganese 1.20 and silicon .75 per cent; applications include planer ways. Lukens Steel Co., Coatesville, Pa.

- - - - - - - **7** - - -

CROMIN D; nickel-chromium-iron for electrical uses; high resistivity, for use in low temperature work. Gilby Wire Co., Newark, N. J.

- - **3** - - - - - - -

CRO MOL; C-9 and C-10; chrome molybdenum cast steel for hammer parts, rams, dies, and saw blocks. Continental Roll & Steel Foundry Co., East Chicago, Ind.

1 2 - - - **6** - - - -

CRUCIBLE; stainless irons; a group of steels containing 12 to 30 per cent chromium, including No. 12 (12 to 15 chromium); No. 2 (12 to 15 chromium); No. 18 (16 to 19 chromium); No. 21 (19 to 23 chromium); No. 27 (23 to 30 chromium); No. 182 (18 chromium, 2 nickel); all have .12 max. carbon. Stainless steels; a group similar to

the foregoing except having a higher carbon content; used mainly for bearings, etc. where hardness and resistance to corrosion is desired; Stainless A (.3 carbon, 12 chromium); B (.60 carbon, 16 chromium); Stainless H.C. (1.00 carbon, 20 chromium with vanadium and molybdenum). Rezistals; KA2 (18 chromium, 8 nickel) and its modifications; No. 3 (22 chromium, 12 nickel, 2.50 silicon); No. 4 (20 chromium, 25 nickel, 2.50 silicon); No. 7 (NCT3) (25 chromium, 25 nickel, 1.00 silicon). Nitralloy; alloy steel of the standard patented chrome-aluminum-molybdenum analysis; additional compositions featuring aluminum and high molybdenum, as well as special chrome-vanadium combinations. Crucible Steel Co. of America, New York.

- - - - - - - **7** - - -

CUPRON; nickel copper alloy for rheostats, voltmeters, shunts and other resistances operated below red heat; has moderate resistivity. Gilby Wire Co., Newark, N. J.

1 - - - - - - - - - - -

CYCLOPS; No. 17; a noncorrosive steel for pump rods, still plugs, thermocouple wells, turbine blades, etc. Stainless grade A; chromium 12.50, nickel .50 max. Grade B; chromium 17, nickel .50 max. Cyclops Steel Co., Titusville, Pa.

Additions to listings:

D

1 - - - - - - - - - - -

DAVIS METAL; a corrosion resisting iron; for valves and fittings; carbon and silicon 0.5, manganese 1.5, nickel 29, iron 2, copper 67 per cent. Chapman Valve Mfg. Co., Indian Orchard, Mass.

1 2 - - - - - - - - - -

DEFIHEAT; major property is heat resistance; carbon .20 max., manganese .25 to .80, phosphorus .035, sulphur .035, silicon 1.00, chromium 26 to 29; will withstand temperatures up to 2100 degrees Fahr. indefinitely. Rustless Iron Corp. of America, Baltimore.

1 2 - 4 5 - - 8 - - -

DEFIRUST; corrosion resistance is principal property; carbon under .10, manganese .25 to .60, phosphorus .035, sulphur .035, silicon .50, chromium 12 to 14.50. Special Defirust; corrosion, heat resistant, high ductility; carbon .10 max., chromium 16 to 18, other elements in same percentages as in above alloy. Rustless Iron Corp. of America, Baltimore.

1 2 - 4 5 - 7 - - -

DEFISTAIN; corrosion and heat resistance are major properties; carbon .18 and .07, manganese .25 to .60, phosphorus .035, sulphur .035, silicon .75 max., chromium 17 to 19, nickel 8 to 10; retains high tensile strength and resistance to creep up to 1300 degree Fahr.; is nonmagnetic. Rustless Iron Corp. of America, Baltimore.

- - **3** - - - - **8** - -

DEWARD; grade 8; carbon .9; manganese 1.50, molybdenum .30; for holders for thread chasers and gang punches. Ludlum Steel Co., Watervliet, N. Y.

- - - - - **6** - - - -

DIAMOND G BRONZE; for bearings,

bushings and mill brasses. E. A. Williams & Son Inc., Jersey City, N. J.

1 2 - - - - - - - - - -

DM STEEL; exceptionally good resistance to creep up to 1200 degrees Fahr. combined with fair oxidation and corrosion resistance; carbon under .20, manganese .30 to .60, silicon .75 to 1.25, chrome 1 to 1.50, molybdenum .40 to .60, phosphorus .04 max., sulphur .04 max.; for power and oil refinery equipment such as tubing. Timken Steel & Tube Co., Canton, O.

1 - - 4 5 - - 8 9 10

DOWMETAL; Grade A; high tensile strength and ductility, good machinability and low specific gravity, this being the major characteristic; magnesium 91.8, aluminum 8, manganese .2; castings for aircraft, portable machinery, etc. Grade F; properties similar to A; magnesium 95.7, aluminum 4, manganese .3; sheet and wrought shapes for aircraft and transportation industry. Grade G; magnesium 89.9, aluminum 10, manganese .1; castings for aircraft and portable machinery requiring high yield strength rather than high ductility. Grade M; possesses good machinability and in addition is corrosion resistant; magnesium 98.5, aluminum 1.5; sheet and wrought shapes principally for the aircraft industry for stressed parts requiring maximum resistance to salt water. Dow Chemical Co., Midland, Mich.

- - - 4 5 - - - - -

DUPLEX; forging steel; nickel 3.50, chromium 1.50; for shafts and machine parts where high strength and toughness are required; also made in case carburizing type. Crucible Steel Co. of America, New York.

- - 3 - - - - - - -

DUQUESNE SPECIAL; chrome molybdenum steel for rolls subject to severe service; also for abrasive castings. Continental Roll & Steel Foundry Co., East Chicago, Ind.

- - 3 - 5 - - 8 - -

DURALLOY; 1 to 2 chromium, 1 to 3.50 nickel; steel castings for treads, gear blanks, etc. West Steel Casting Co., Cleveland.

1 - - - - - - - - - -

DURALOY; A (27 to 30 chromium), B (16 to 18 chromium), C (12 to 14 per cent chromium), N (21 to 24 chromium, 12 nickel), 18-8 (18 chromium and 8 nickel), 15-35 (15 chromium, 35 per cent nickel); for corrosion resisting castings. Duraloy Co., Pittsburgh.

1 - - - - - - - 8 - -

DURCO; alloy steels (KA2S, KA2SMo, etc.); 18 chrome, 8 nickel, carbon maximum .07 per cent, and other standard as well as special analyses preferred by users; for pumps, valves, fittings, castings for corrosive service. Duriron Co. Inc., Dayton, O.

- - - - - 6 - - - -

DUREX; principally used for bearings; copper 85 to 88 per cent, tin 9.4 to 9.8 per cent, graphite 2 to 6 per cent; for bearings for motors, automobiles, washing machines, electric refrigerators, farm implements, etc. Moraine Products Co., Dayton, O.

1 - 3 - - - 7 - - -

DURICHLOR; silicon 14, molybdenum 4, carbon .80, traces of phosphorus and sulphur, balance iron; for pumps, valves, pipe, castings for corrosive service, especially for hydrochloric acid and chloride solutions. Duriron Co. Inc., Dayton, O.

1 2 - - - - - - - - -

DURIMET; nickel 23 per cent, chromium 20, silicon 3, molybdenum 1.25, copper 1, carbon .07, balance iron; for pumps, valves, bolts, nuts and

castings for corrosive service. Duriron Co. Inc., Dayton, O.

1 - 3 - - - 7 - - -

DURIRON; silicon 14.50, carbon .80, manganese .60, sulphur and phosphorus traces, balance iron; for pumps, valves, ejectors, exhaust fans, mixing nozzles and special equipment and castings for handling acids and other corrosive liquids and gases. Duriron Co. Inc., Dayton, and licensees including Shawinigan Chemicals Ltd., Montreal, Que.

- - - - - 6 - - - -

DUTCH BOY BABBITT; for bearings; analysis varies for different applications. National Lead Co., New York.

1 - 3 - - - - 8 - 10

DYNAMIC STEEL; C-2; low carbon, manganese, nickel cast steel for parts requiring high physical properties; for tractor frames, locomotive castings, material moving machinery. C-3; medium carbon, manganese, nickel cast steel for resisting wear after a preferential heat treatment; for sprockets, spindles, wheel centers, crossheads, etc. C-6; high chromium cast steel for special abrasive and crushing work; for sand mills, rock crushers, etc. Continental Roll & Steel Foundry Co., East Chicago, Ind.

Additions to listings:

E

- - - 4 5 - - 8 - 10

ECONOMO; free machining; .20 and .50 carbon with alloy of molybdenum; for machine tool parts. Wheelock Lovejoy & Co. Inc., Cambridge, Mass.

ELECTROMET; a line of ferro-alloys and alloying elements of various analyses. Electro Metallurgical Co., New York.

- - - - - - - - - - 10

ELINVAR; alloy with low coefficient of elasticity; nickel 33 to 35 per cent, iron 53 to 61, chromium 4 to 5 per cent, tungsten 1 to 3, manganese .5 to 2, silicon .5 to 2, carbon .5 to 2 per cent; for watch and instrument hairsprings, and tuning forks; made by Acieries d'Imphy, France. Marketed in the United States and Canada by R. Y. Ferner Co., Washington.

- - 3 - - - - - - -

ELVERITE; special castings with wear-resisting qualities; for tube mill linings, wheels, jaw crushers, sprockets, etc. Fuller Lehigh Co., Fullerton, Pa.

1 2 3 4 5 - - - - -

EMPIRE; alloy steel castings to all standard chrome-nickel specifications. Empire Steel Castings Inc., Reading, Pa.

- - - - - - - - - 10

ENDURIA; a special carbon spring steel. Bethlehem Steel Co., Bethlehem, Pa.

1 2 - - - - - - - -

ENDURO; 18-8, 18 chromium and 8 nickel; AA, 18 chromium; S and S-15, 13 per cent chromium; stainless irons resistant to heat and corrosion. AA; heat resisting alloy; chromium 16.5 to 18.5, silicon .75,

carbon .1 max. Republic Steel Corp., Youngstown, O.

- - 3 4 5 - - - - - -

ERMAL; high tensile, close grained, ductile iron; for all general castings; excellent in resistance to wear by friction or abrasion. Erie Malleable Iron Co., Erie, Pa.

- - 3 - - - - - - - 10

ERMALITE; wear resisting alloy iron; for gears, wearing plates, friction drums and other parts subject to high stresses or wear. Erie Malleable Iron Co., Erie, Pa.

- - - 4 5 6 7 - - -

EVANSTEEL; nickel 1 to 1½ per cent, chrome .65 to 1, carbon varies from .30 to .50, sometimes carries additions of vanadium or molybdenum; for castings such as passenger car buckles, tooth bases, sprockets, gears, high pressure valves, etc. Chicago Steel Foundry Co., Chicago.

1 - - 4 5 - - - - 10

EVERDUR; grade A; copper 96, silicon 3, manganese 1. B; copper 98.25, silicon 1.50, manganese .25; for strength and resistance to corrosion; easily fabricated by all methods including welding. Uses for grade A include boilers, tanks, sewage disposal and water treatment apparatus; B is used for tubes, bolts and screws. American Brass Co., Waterbury, Conn.

Additions to listings:

F

1 2 - - - - - - - - - -

FAHRITE; N-1 and N-5; heat resistant. N-1; carbon .40 max., nickel 35 to 38, chromium 15 to 18. N-5; carbon .40 max., nickel 60 to 65, chromium 12 to 14; for mechanical furnace parts, etc. N-2; corrosion resistant; carbon .25 max., chromium 18 to 20, nickel 8 to 10; for valves and pressure castings, etc. N-3; corrosion and heat resistant; carbon .40 max., chromium 24 to 26, nickel 8 to 9 per cent; for mechanical furnace castings, etc. Ohio Steel Foundry Co., Springfield, O.

- - 3 4 5 - - - - 10

FARRELL'S 85; specially processed steel castings for resisting abrasion; possessing high strength, toughness and rigidity. Farrell-Cheek Steel Foundry Co., Sandusky, O.

- 2 - - - - - - - - -

FIRE ARMOR; castings resistant to high temperatures; nickel 60, chromium 20, iron 10, manganese 1.75, and carbon 0.5. Michiana Products Corp., Michigan City, Ind.

- - - - - - 6 - - - 10

FEDERAL-MOGUL; bearing bronzes; F1; a good gear bronze and is suitable for heavily loaded piston pin bushings, etc. F2; one of the strongest and hardest of the lead bronzes for average bushing application. F8; good casting and machining qualities. F15; has 20 per cent lead and may be used safely under adverse lubrication conditions. F5; widely used for babbitt lined bearing backs and for bushings where service is not severe. F16; because of high lead content may be used where only occasional lubrication is possible. F3; used largely as backs for babbitt lined bearings. F6; for average bushing applications. F11; for piston pin bushings and other low speed, heavily loaded applications. F13; suitable for many of the uses to which F1 is applied. F19; strong ductile alloy of average hardness with

bearing qualities corresponding to other low lead compositions. F 18; high lead alloy of good casting characteristics. Federal-Mogul Corp., Detroit.

\- - 3 - - - - - - - - -

FLINTCAST; an abrasion-resisting iron. Pacific Foundry Co., San Francisco, Calif.

Additions to listings:

G

1 - - - - 5 - - - - -

GOH1; iron-copper alloy; .02 per cent carbon, manganese .025, sulphur .025, phosphorus .005, silicon .003, copper .25 per cent; for any sheet or plate application where corrosion resistance and ductility are a consideration as in ventilating systems, fabricated sheet metal parts, etc. Newport Rolling Mill Co., Newport, Ky.

\- - - 4 - - - - - - -

GUNITE; low carbon high test cast iron; for brake drums, clutch plates, glass molds, cylinders, dies, hydraulic castings, and machine tool parts. Gunite Foundries Corp., Rockford, Ill.

Additions to listings:

H

1 2 - - - - - - - - 10

HALCOMB; stainless steels; Grade A; chrome 12.5. B; chrome 17. Stainless irons, FM2; chrome 12; for free machining, corrosion resistant. No. 12; chrome 12 to 13. No. 16; chrome 15 to 16. No. 18; chrome 18 to 20. No. 24; chrome 24 to 26. N. C. R. 238; heat and corrosion resistant. Rezistal; stainless steels made in various grades, corrosion, heat resistant. Halcomb Steel Co., Syracuse, N. Y.

\- 2 3 - - - - - - - 10

HARDTEM; abrasion resistance is primary property; carbon .5, nickel chrome molybdenum die steel; for die blocks, upsetter blocks, shafting applications. Heppenstall Co., Pittsburgh.

1 - 3 - - - - - - - -

HAYNES STELLITE; major property is abrasion resistance; nonferrous cobalt-chromium-tungsten alloy for metal cutting tools, hard facing welding rod for parts subjected to abrasion or a combination of abrasion, heat and corrosion. Haynes Stellite Co., New York.

\- - 3 - - - - - - - -

HAYSTELLITE; primarily resistant to abrasion; cast tungsten carbide; for inserts and composite rod (welding rod) for oil well drilling tools, dredge cutter blades, etc. Haynes Stellite Co., New York.

1 - - - - - - - - - -

HASTELLOY A, C and D; principally resistant to corrosion. A is comprised of nickel, molybdenum and iron. C; nickel, molybdenum, chromium and iron. D; nickel, silicon, copper and aluminum; for corrosion resistant piping, tanks, pump parts, valves, vessels, etc. Haynes Stellite Co., New York.

\- - - 4 5 - - - - 10

HEPPENSTALL; Grade 2C 30; high impact strength is major property;

nickel chrome molybdenum steel, .3 per cent carbon; for shafting where high torsional strength is required such as drop hammer piston rods. Heppenstall Co., Pittsburgh.

1 - 3 4 5 - 7 8 - -

HERCULOY; silicon bronze; copper 94.75, silicon 3.25, tin .50, zinc 1.50; corrosion, abrasion resistant, high strength and ductility, nonmagnetic; obtainable in form of strip, sheets, plates, cold drawn rods, shafting, welding rod, forgings, ingot form for sand casting; for piston rods, shafting, electrical construction, etc. Produced by Revere Copper & Brass Inc., New York.

- - - 4 - 6 - - - -

HIGH TEST; nickel cast iron possessing high tensile strength; nickel 1 to 1.25, total carbon 2.75 to 3.15, manganese .60 to 1, silicon .9 to 1.10 per cent; for brake drums, diesel engine liners and heads, paper and printing press rolls, and valve bodies. International Nickel Co. Inc., New York, and licensees.

1 - 3 4 - - - - - - -

HIOLOY; 0-3; carbon .35 max., nickel 1 to 1.75, chrome .40 to .80, molybdenum .20 to .30; parts for refinery equipment where strength is major consideration. 0-4; carbon .32 max., chrome 4.00 to 6.00, molybdenum .50 to .65 per cent; for refinery fittings to resist corrosion. 0-6; abrasion resistant; carbon .75 max., chrome .80 to 1.20, vanadium .15 to .22; for cement mill liners and screen plates, conveyor pipe for abrasive materials, sand mill parts, etc. Available in cast form. Ohio Steel Foundry Co., Springfield, O.

- - - - - - 6 - - - -

HOYT BABBITT METAL; for bearings; analysis varies according to application. National Lead Co., New York.

- - 3 - - - - - - - -

HUBBARD SPECIAL; nickel chrome steel for wear resisting rolls, guides, and miscellaneous castings. Continental Roll & Steel Foundry Co., East Chicago, Ind.

1 - - - - - - - - - -

HYB-LUM; a corrosion resisting, general purpose alloy containing nickel, copper, silicon and pure aluminum. Produced by Sheet Aluminum Corp., Jackson, Mich.

1 2 - - - - - - - - -

HYBNICKEL, "A," "B," "C," "D," "R" and "S;" a series of nickel-chromium alloys for heat and acid resistance. Victor Hybinette, Wilmington, Del.

1 - - - - - - - - 9 -

HYDRONALIUM; aluminum alloys resistant to corrosion, especially in sea water; magnesium 5 to 15 per cent, with traces of manganese. For ships and aircraft. Bitterfeld Works of I. G. Farbenindustrie A-G., Germany.

- - - 4 - - - - - -

HYLASTIC; greater strength with no increase in weight; carbon .35, manganese 1.50, phosphorus .05, sulphur .05. Available in cast form. American Steel Foundries, Chicago.

- - - - - - 6 - - - -

HY-SPEED; for bushings, bearings and bars; copper 88, tin 7 and zinc 2 per cent. Buckeye Brass & Mfg. Co., Cleveland.

1 - - - - - - 7 - - -

HYTEMCO; for electrical uses primarily; nickel 70 per cent, balance iron; ballast resistances, heater pad element material, resistance thermometers, etc. Driver-Harris Co., Harrison, N. J.

- - 3 4 5 6 - 8 - -

HY-TEN; .10 to 1 carbons of chrome-manganese-molybdenum and chrome-nickel-molybdenum alloys; for small

tools and machine tool parts. Wheelock-Lovejoy & Co. Inc., Cambridge, Mass.

Additions to listings:

I

1 2 - - - - - - - - - -

ILLIUM; alloy consisting primarily of nickel, chromium, copper, molybdenum and tungsten; for resistance to sulphuric acid, nitric acid and other highly corrosive conditions in the chemical industry. Burgess-Parr Co., Moline, Ill.

1 2 3 4 5 - - - - - -

INCONEL; nickel 80, chromium 14 and iron 6 per cent; principal applications include handling of food products of which non-contamination is desired, springs, high temperature applications. International Nickel Co. Inc., New York, and licensees.

1 - 3 4 5 - - - - 10

INDUSTRIAL; Super-Duct F-3; high strength and ductility, resistant to abrasion; chromium .80, nickel 1.75, molybdenum .35 per cent; for shafts, studs, etc. Stainless steel No. 35; chrome 13 to 14, carbon .30 to .40; No. 65, chrome 16 to 17, carbon .60 to .70; No. 100; chrome 17 to 18, carbon .9 to 1. Stainless iron, No. 512; free machining, chromium 11½ to 13; No. 12, 11½ to 13; No. 18; chromium 16 to 20; No. 188; chromium 17 to 20, nickel 8 to 10; No. 5188 free machining; chromium 17 to 20, nickel 8 to 10; No. 188 M; chromium 17 to 20, nickel 8 to 10, molybdenum 2 to 4 per cent. Industrial Steels Inc., East Cambridge, Mass.

1 2 - 4 5 - - - - - -

ING O CLAD; stainless clad steel; consisting of a 20 per cent stainless layer of 18-8 chrome nickel, or 20-10 chrome nickel, or straight 16-18 chrome bonded to a back of soft carbon steel. Uses include equipment for chemical plants, and the food, dairy, processing, brewery and packing house industries, and other fabricating units requiring a stainless steel surface on one side. Ingersoll Steel & Disc Co., division of Borg-Warner Corp., Chicago.

1 - - - - - - - - - - -

INLAND; copper bearing steel used largely for sheets; corrosion resisting; copper minimum .20 per cent. Silico-manganese spring steel. Inland Steel Co., Chicago.

- - - - - - - - - - - 10

INVAR; an alloy with a low coefficient of thermal expansion; nickel 36 per cent; iron 61 to 64, carbon 0 to 1 per cent, manganese .1 to 1 and silicon .1 to 1 per cent; for clock pendulums, scientific instruments, and struts for auto pistons; made by Acieries d'Imphy, France. R. Y. Ferner Co., Washington, is exclusive agent in United States and Canada.

- - 3 - - - - - - - -

IRONITE; wear resisting castings; nickel, vanadium and chromium composition. Kinite Corp., Milwaukee.

Additions to listings:

J

- 2 3 4 5 6 - - - -

JEWELL ALLOY; carries 1.25 nickel, 2.50 total carbon, .90 silicon and .3 chromium; castings for machine parts, cams, compressor valve seats and valve inserts. Jewell Steel & Malleable Co., Buffalo.

1 - - - - 6 - - - -

JOHNSON; bronze alloy, No. 19; high wear rating and resistance to pounding; copper 70, tin 11, lead 19; for mill bearings, gas and diesel engines, excavating, pulverizing and general machinery bearings. No. 25 (plastic bronze); copper 75, tin 5, lead 19, nickel 1; for high speed with light to medium load and generally free from shock; because it has good acid resistance it is particularly suitable for pump bearings and sleeves, also for electric motor, conveyor and fan, and wood working machine bearings. No. 27; copper 80, tin 10, lead 10, deoxidized with phosphorus; for locomotive crossheads and crank pin bearings, lathe, and grinder and other high speed applications. No. 29; copper 78, tin 7, lead 15; for use where spindle is of soft steel and speed relatively high; acid resisting alloy. No. 53; copper 88, tin 10, zinc 2; good bronze for severe service or heavy pressures; should be used where shaft is hardened steel and well lubricated. No. 72; copper 83, tin 7, lead 7, zinc 3; best suited for moderate speeds and low loads. Babbitt alloy, No. 10; tin 90, antimony 5, copper 5; suitable for thin linings and also may be used in die castings. No. 11; tin 87, antimony 7, copper 6; rather hard babbitt recommended as lining for connecting rods and shaft bearings subjected to heavy pressures. No. 12; tin 90, antimony 7.5, copper 2.5; for high speeds and acts well where higher temperatures are encountered. Johnson Bronze Co., New Castle, Pa.

Additions to listings:

K

- - 3 - - - - - - 10

KINITE; high carbon steel castings; resistant to abrasion and compression; for cutters, mandrils, machine parts, press tools, etc. Kinite Corp., Milwaukee.

- - 3 - - - - - - -

KLEENKUT; tool steel containing 2 carbon and 12 per cent chromium; for shear knives for cold shearing light material. Heppenstall Co., Pittsburgh.

1 2 - 4 5 - 7 8 - -

KONAL; analysis depends on application, broadly nickel-cobalt alloys with substantial percentages of iron, titanium and chromium; for thermionic filaments, internal combustion engine valves, molds and machine parts subject to stress at temperatures up to 650 degrees Cent. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

- - - - 5 - 7 - - 10

KOVAR; low expansion to 400 degrees Cent.; approximately 30 per cent nickel, 15 cobalt and 55 iron; for sealing into hard glass, mercury arc rectifiers. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Additions to listings:

L

- 2 - - - - - - - -

LO-CRO; 46 (5 chromium) including 46Mo. (5 chromium, .50 molybdenum)

and 46W; widely used where resistance to scaling up to 1200 degrees Fahr. is desired and where high strength at elevated temperatures up to 1200 degrees Fahr. is required. Crucible Steel Co. of America, New York.

\- - - - - - **6** - - - -

LOTUS BABBITT; a lead base babbitt for bearings. Lumen Bearing Co., Buffalo.

\- - - - - - **6** - - - -

LUBRICO; for bearings, bushings and bars; copper 75, lead 20 and tin 5 per cent. Buckeye Brass & Mfg. Co., Cleveland.

1 - - 4 5 6 7 8 - 10

LUMEN; Bronze, a zinc base alloy for bearings. Alloy No. 00A; high tin bronze for high compression bearing application. No. 00C; high tin bronze for high compression bearing application. No. 1; zinc bronze possessing high ductility for machine parts, pressure castings, etc. No. 2; zinc bronze for machine parts, bearings, etc. No. 3; corrosion resistant; zinc bronze, for mine service and paper mill machinery bearings. No. 4 and 4A; phosphor bronze (leaded) for bearings. No. 5; general service alloy; red brass; for pressure bodies, etc. No. 6; phosphor bronze (leaded) for bearings. No. 7; phosphor bronze; electrical uses, including trolley wheels, etc. No. 9; manganese bronze; possesses high tensile strength; for machine parts. No. 11-C; aluminum bronze; corrosion resistant, high tensile strength, heat treating; for miter and bevel gears, etc. No. 14; zinc bronze; babbitt backing; for valve bodies, etc. No. 15 and 15A; phosphor bronze; for worm wheels, bearings, etc. No. 20; super-manganese bronze; high tensile strength; for machine parts. No. 27; aluminum bronze; high tensile strength, heat treating, corrosion resistant; for strength parts. No. 31 and 33; high lead bronze for bearings. No. 48; nickel phosphor bronze, for bearings, worm wheels, etc. No. 54; phosphor bronze (leaded), for bearings. Produced by Lumen Bearing Co., Buffalo.

\- - **3 4** - - - - **8** - -

LXX; grade 55; tungsten 18, chromium 4, vanadium 1; for lathe centers for severe service. Ludlum Steel Co., Watervliet, N. Y.

Additions to listings:

M

\- - - **4 5** - - - - - -

MACALLOY; carbon .35, nickel .90, chromium .50, molybdenum .10 per cent; for parts requiring high strength and toughness. Colonial Steel Co., Monaca, Pa.

\- - **3 4** - - - - - - - -

MACHEMPITE "Wearprooft"; alloy cast, forged or rolled steel; for gears, pinions, locomotive guides, crossheads, track wheels, sprockets, brake drums, conveyor parts, spindles, coupling boxes, cams, etc. Mackintosh-Hemphill Co., Pittsburgh.

\- - - - - - **6** - - - -

MACHINEBRONZE; a zinc bronze for general bearing requirements; cored and solid bars. Lumen Bearing Co., Buffalo.

\- **2** - - - - - - - - - -

MACKENITE METAL; heat resistant; for retorts, annealing pots, cylinders

and lead pan castings. Duncan Mackenzie's Sons Co., Trenton, N. J.

- - 3 - - - - - - - - -

MAL-ARC; a hard surfacing material marketed in the form of an electrode. For application to machine parts, where abrasion is encountered. P. R. Mallory & Co. Inc., Indianapolis.

- - - - - - - - 7 - - -

MANGANIN; copper, nickel and manganese alloy; for electrical uses including shunts, wheatstone bridges, and other precision instruments; possesses moderate resistivity, low temperature coefficient, low thermal E. M. F. against copper. Gilby Wire Co., Newark, N. J.

- - - - - - - - - 8 - 10

MANGANO; carbon 0.95, manganese 1.60, chromium 0.20; used where nonshrinking, oil quenching steel is required. Latrobe Electric Steel Co., Latrobe, Pa.

- - 3 - - - - - - - - -

MARTIN STEEL; air hardening tool steel castings; chromium 12 to 14, cobalt .7 to .9, and carbon 1.5 to 1.6 per cent. Detroit Alloy Steel Co., Detroit.

- - 3 4 - - - - - - - -

MASSILLON; worm alloy; alloy cast steel, heat treated to give maximum wear and abrasive qualities; for domestic, industrial and locomotive stoker worms; SAE 9260; chrome-molybdenum, for coal mining machinery, and coal cutting links. Massillon Steel Casting Co., Massillon, O.

- - - 4 5 - - - - - -

MAX-EL; machinery steels used where strength and toughness combined with ease of machining is desired; several grades, plain and alloy, varying in carbon from .10 to .80 to suit requirements. Crucible Steel Co. of America, New York.

- - - 4 5 - - - - - -

MAYARI "A"; a chrome nickel steel; for bolts, auto parts, axles, tools, etc. Bethlehem Steel Co., Bethlehem, Pa.

1 2 3 4 - - - 8 - -

MEEHANITE; a sorbo-pearlitic iron containing silicon, manganese, phosphorus, sulphur and carbon, the analysis depending upon the mixture which in turn depends upon the application; resistant to temperature, corrosion and wear; has high tensile strength; for rolls, wear plates, gears pump cylinders, etc. Cast by licensed foundries in all important industrial centers in the country.

- 2 - - - - - - - - - -

MICHIANA; Type 25-12; 18-8; 30-8; No. 48. Alloys of varying analysis for conditions of temperature and corrosion. Michiana Products Corp., Michigan City, Ind.

1 2 - - - - - - - - - -

MIDVALOY; stainless steel A; chromium 9 to 16, carbon over .12.B; chromium over 16, carbon over .12. Stainless steel 7; castings only; chromium 20, carbon .25, copper 1. Stainless iron C1; chromium 15 max., carbon .12 or under. C2; chromium 15 to 18, carbon .12 or under. C3; chromium 18 to 23, carbon .12 or under. C4; chromium 23 to 30. Cromaloy; chromium over 21, carbon low, silicon 1.5 to 3. All of the above alloys are primarily corrosion resistant. Grade HC; heat resistant; chromium 27, nickel 2 max., carbon as required. HR1; chromium 20, nickel 7, carbon .35, tungsten 4. Grade 18-8; corrosion resistant, chromium 18, nickel 8, carbon .06 up. Grade 25-10; corrosion resistant; chromium 25, nickel 10, carbon low. Grade B; heat resistant; chromium 23, nickel 11, carbon 1. Grade 25-20; corrosion resisting; chromium 25, nickel 20, carbon low, molybdenum .2. Aero Valve; heat, corrosion resistant; chromium 14, nickel 20, carbon .60, tungsten 2. Grade HY-X; heat, corrosion resistant; chromium 8, nickel 22, carbon low, copper 1. Grade ATV-3; heat and corrosion resistant; chromium 14, nickel 26, carbon .45, tungsten 3.5. Grade 30-30; chromium 30, nickel 30, carbon low, heat resisting. Grade A;

heat resisting; chromium 19, nickel 35, carbon low. Grade ATV-1; heat and corrosion resisting; chromium 11, nickel 36, carbon .35. Grade BTG; heat resisting; chromium 11, nickel 60, carbon .30, tungsten 2.5. Grade AMF; corrosion resisting. Grade 976; heat and corrosion resistant; for auto and diesel engine valves. Also KA2, KA2S, KA2Mo, KNG-3, castings only. Applications for the entire line include machines in the chemical and refining industries, mining and metallurgical work, rolls for paper machinery, impellers for exhaust gases, mechanical stoker parts, hydraulic machinery parts, etc. Midvale Co., Nicetown, Philadelphia.

\- - - - - - 6 - - - -

MILL BRASS MIX; bearings, bushings and mill brasses. E. A. Williams & Son Inc., Jersey City, N. J.

\- - - 4 5 - - - - -

MIRACULOY; strength and ductility combined; chromium, nickel, manganese and molybdenum castings. Sivyer Steel Castings Co., Milwaukee.

1 2 - 4 5 - - 8 - -

MISCO; Metal; nickel 35 to 37, carbon .50 to .70, chromium 15 to 17; high load carrying capacity up to 1950 degrees Fahr.; resistant to sulphuric acid; furnace parts, carburizing boxes, pots, retorts. Grade 18-8, chromium 18 to 20, nickel 8 to 10, carbon to suit; for valve and pump parts. Grade B; chromium 24 to 26, nickel 12 to 14, carbon .20 to .30; for furnace parts in sulphurous atmosphere. Grade B-1; chromium 24 to 26, nickel 12 to 14, carbon .40 to .60; for furnace parts in sulphurous atmosphere. Grade C; chromium 28 to 30, nickel 8 to 10, carbon .20 to .30; for valve fittings and pump parts for sulphite service. Grade C1; chromium 28 to 30, nickel 8 to 10, carbon .40 to .60; for high-heat furnaces where sulphurous compounds are present. Grade N; chromium 8 to 10, nickel 20 to 22, carbon .30 to .50; for valve and pump parts for alkali and sea water; heat resistant up to 1500 degrees Fahr. Grade HN; nickel 60 to 65, chromium 15 to 18, carbon .60 to .80; for retorts, lead baths, etc. Grade N-5; nickel 30, silicon 3 to 5, carbon .30 to .50; resistant to sulphuric acid. Cast and rolled. Michigan Steel Casting Co., Detroit.

1 2 3 4 - - - - - - -

MISCROME; grade 1; chrome 16 to 17, carbon .20 to .30; for pump and valve parts; nitric acid resistant and heat resistant up to 1400 degrees Fahr. as in hot oil handling equipment. Grade 2; chromium 18 to 23, carbon .20 to .30; posseses high tensile strength; for pump and valve parts, etc; nitric acid resistant and heat resistant up to 1600 degrees Fahr. Grade 3; 26 to 30 chromium, .20 to .30 carbon; for severe nitric acid conditions; heat resistant up to 2200 degrees Fahr.; ore roaster parts, furnace rails and parts subject to low stress at high temperature (1800 to 2200 degrees Fahr.). Grade CR; 14 to 17 per cent chromium, 2 to 3 carbon; heat and abrasion resistant (mild cases); heat resistance up to 1400 degrees Fahr. Grade KR; chromium 26 to 30 per cent, carbon 2.0 to 3.0; abrasion resistant. Cast and rolled. Michigan Steel Casting Co., Detroit.

\- - 3 - - - - - - - -

MOLYBDENITE; special chrome molybdenum steel casting for mill pinions, guides and rolls. Continental Roll & Steel Foundry Co. East Chicago, Ind.

1 2 3 4 5 - - - - 10

MO-LYB-DEN-UM; an alloying element for use in steel and iron; imparts strength, toughness, ductility and resistance to abrasion; improves fatigue value, increases physical properties at elevated temperatures; easily welded and an aid to machinability. Climax Molybdenum Co., New York.

\- - - 4 5 - - 8 - -

MO-LYB-DIE; Type 1; carbon .31, manganese .55, chromium .75,

nickel 1.50, molybdenum .25, silicon .20, phosphorus and sulphur .04 max. Type 2; carbon .40, manganese .55, chromium .75, nickel 1.50, molybdenum .25, silicon .20, phosphorus and sulphur .04 max. Type 3; carbon .55, manganese .55, chromium .75, nickel 1.50, molybdenum .30, silicon .20, phosphorus and sulphur .04 max. Applications include machine parts subject to extreme torsional strains, shock, vibration. A. Finkl & Sons Co., Chicago.

1 - 3 4 5 - - - - -

MONEL METAL; nickel 68, copper 29, balance iron, manganese silicon, carbon, general purpose alloy for use under corrosive conditions. International Nickel Co. Inc., New York, and licensees.

- - - - - 6 - - - -

MORAINE; bearings and bushings, rolled brass split type; for automobiles and electric motors. Moraine Products Co., Dayton, O.

1 - 3 4 - 6 - - - -

MUELLER 600 BRONZE; forgeable bearing metal; to resist abrasion and for bearing applications; copper 60 per cent, zinc 35 per cent, other metals 5 per cent; for worm gears, driven gears, connecting rods, seal rings for refrigerators, crankshafts for oil pumps, etc. Mueller Brass Co., Port Huron, Mich.

Additions to listings:

N

1 2 3 - - - - - - - -

NA, NA-1, NA-2; alloy steel, resistant to heat, corrosion and abrasion, in varying percentages of nickel and chromium. National Alloy Steel Co., Blawnox, Pa.

1 - - - - - - - - 9 -

NATIONAL; corrosion resistant light weight alloys; aluminum alloyed with various hardeners to meet special casting requirements. National Smelting Works, Cleveland.

1 2 3 4 5 6 - 8 - -

NEVASTAIN; CA grade 81; corrosion, abrasion, heat resistant, high tensile strength and ductility, suitable for bearing application; carbon .35, chromium 13; for pump shafts and machine parts. CB grade 82; similar properties; carbon .70, chromium 17; for pump shafts, oil machinery, etc. CC grade 523; corrosion, heat, abrasion resistant, high tensile strength; chromium 12, copper 1, low carbon; for pump shafts and plungers for hot and cold liquids. Especially suited for noncorrosive springs exposed to elevated temperatures. H grade 84; corrosion, heat, abrasion resistant, high tensile strength and bearing application; carbon 1, chromium 17, silicon 1; for pump shafts and other machine parts. S grade 85; corrosion, heat abrasion resistant, and possesses high tensile strength and ductility; carbon .12, chromium 14. RA grade 521; corrosion, heat, abrasion resistant, high tensile strength and ductility; chromium 16, copper 1, low carbon; for valves, spindles, etc. Ludlum Steel Co., Watervliet, N. Y.

1 - - - - - - - - - -

NIAGARA; a line of alloying elements comprising some three hundred and fifty combinations applicable for deoxidizing and fluxing all types of metals intended for casting, and at the same time provid-

ing greater resistance to corrosion and higher pressure qualities such as are encountered in pumps and valves. Produced by the Niagara Falls Smelting & Refining Corp., Buffalo.

1 2 3 4 5 - 7 8 - -

NICHROME; principally heat resistant but also corrosion and abrasion resistant; nickel 62, chromium 15; heating element material for electrical heating devices, irons rheostats, potentiometers, etc. Type B; for addition to cast iron; sold in ratios of 5, 3, 2 parts of nickel to 1 part of chromium; improves quality and physical properties of cast iron when added to ladle. Grade S (sheet); nickel 27, chromium 15; welded tubing, etc. Type V; principally heat resistant but also possessing resistance to corrosion, high tensile strength, high ductility; heating element material for electric ranges, industrial furnaces, etc. V; sheet of similar analysis; used for welded tubing, etc. Cast Nichrome; principally corrosion resistant, for furnace parts, pyrometer protection tubes, glass rolls, conveyor chains, diesel engine valves, etc. Sheet Nichrome; same properties; nickel 60, chromium 15; for welded tubing, etc. Produced by the Driver-Harris Co., Harrison, N. J.

- - - - - - - - - 9 -

NICRAL; a complete series of light aluminum alloys in various forms and tempers. Nicralumin Co., Jackson, Mich.

- - 3 - - - - - - - -

NI-HARD; cast iron; nickel 4½, chromium 1½, total carbon 2.7 to 3.6 per cent; for chilled rolls, cement grinding balls, etc. where abrasion is encountered. International Nickel Co. Inc., New York, and licensees.

- - - - - - - - - - 10

NILVAR; low expansion is principal characteristic; nickel 36, balance iron; for surveying instruments, bimetallic strip, astronomical instruments, thermostatic controllers for electric ovens, gas ovens, etc.; also for sealing in glass and for sealing through quartz for X-ray tubes. Driver-Harris Co., Harrison, N. J.

1 2 - - - - - - - - - -

NI-RESIST; cast iron; nickel 14, copper 6 and chromium 2 per cent; for castings handling corrosive waters and other solutions, or heats above the range of temperature where ordinary cast iron gives good service. International Nickel Co. Inc., New York, and licensees in various industrial centers.

- - - 4 - 6 - - - -

NI-TENSYLIRON; nickel 1 to 4, total carbon 2.50 to 3.15, silicon 1.20 to 2.75, manganese .5 to .9 per cent; for machine tool castings, diesel engine housings, automobile cylinder blocks and pistons, etc. International Nickel Co. Inc., New York, and licensees.

1 - 3 4 5 6 - 8 - -

NITRALLOY; a chromium-molybdenum-aluminum steel capable of developing extreme hardness through nitriding. Republic Steel Corp., Youngstown, O., Crucible Steel Co. of America, New York, Colonial Steel Co., Monaca, Pa., Ludlum Steel Co., Watervliet, N. Y.

- 2 3 - - - - - - - -

NOGROTH; resistant to heat and abrasion; castings of alloy iron, nickel and chrome. The Q & C Co., New York.

1 - - - - - - - - - -

NONCORRODITE; chromium steel castings. Millbury Steel Foundry Co., Millbury, Mass.

1 - - - - - - - - - -

NON-SULITE; corrosion resisting al-

loy. Michiana Products Corp., Michigan City, Ind.

Additions to listings:

O

- - 3 - - - - - - - -

OHIO AIR DIE; carbon 1.60, chromium 12.00 per cent; for parts to resist excessive wear. Colonial Steel Co., Monaca, Pa.

- - - - - 6 - - - - -

OILITE; oilless bronze bearings made from powdered virgin copper, tin and graphite by the sintering method; used extensively in automotive and other industries. Amplex Mfg. Co., division of Chrysler Corp., Detroit.

1 - 3 4 5 - - - - - -

OLYMPIC BRONZE; primary property is high tensile strength; copper 96.25, silicon 2.75, zinc 1 per cent; for strong rail and singeing uses where high strength and corrosion resistance are determining factors; used widely for tanks, bolts, screws, springs, etc. Chase Brass & Copper Co., Inc., Waterbury, Conn.

- - 3 4 5 - - - - - -

ORION; chrome vanadium steel for machine parts because of its high tensile strength and toughness; abrasion resisting also. Cyclops Steel Co., Titusville, Pa.

Additions to listings:

P

1 - - - - - - - - - -

PLYKROME; stainless clad steel embodying a special metallic bond sheet between the veneer of USS stabilized 18-8 and a mild steel backing; for machines employed in the dairy, brewery, canning, chemical and other industries. Illinois Steel Co., Chicago.

- - 3 4 - - - - - -

POMPTON; 10-10½ temper, grade 21; 1 to 1.05 carbon steel; for arbors, bushings, collets and lathe centers. Ludlum Steel Co., Watervliet, N. Y.

- 2 3 4 - 6 - - - -

PROFERALL; electric furnace high test cast iron, low carbon; chrome-nickel molybdenum alloyed; for crankshafts and camshaft castings, high strength heat resisting castings, hydraulic press and pressure castings, dies, etc. Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich.

1 2 - 4 - - 7 8 - -

PYRASTEEL; castings of various analyses; nickel varies from 4 per cent up, chrome from 8 to 26 per cent; for heat treating furnaces, screw conveyors, or any high temperature service up to 2200 degrees Fahr. Chicago Steel Foundry Co., Chicago.

- 2 - - - - - - - - -

PYROCAST; a nickel-chrome iron resistant to high temperatures. Pacific Foundry Co., San Francisco, Calif.

- - 3 4 - - - 8 - -

PYTHON; grade 23; chromium .25, vanadium .25; for chuck jaws, clutch pins and other parts requiring unusual wear and shock resistance. Ludlum Steel Co., Watervliet, N. Y.

Additions to listings:

Q

1 2 3 - - - - - - - -

Q-ALLOY; grade A+; heat resistant; 66 to 68 nickel, 19 to 21 chromium, balance mainly iron; for parts operating in temperatures up to 2200 degrees Fahr., such as continuous furnace mechanisms, conveyors, chains, etc. Chrome CN1; corrosion, heat resistant; 24 to 26 chrome, 11 to 13 nickel, balance iron and small percentage of special alloying elements when required; for general resistance to weathering and corrosive attack of most common acids; also fairly good resistance to high temperatures. Chrome CN2; 18 to 20 chrome, 8 to 10 nickel, balance mainly iron and special alloying elements when required; general resistance to weathering and corrosive attack of most common acids. Chrome C1; corrosion, heat resistant; 26 to 30 chromium with or without low nickel content; for parts in contact with mine water and certain other special acids; fair resistance to high temperatures. Chrome C2; 16 to 18 chromium; for parts in contact with nitric acid, etc. Chrome C3; abrasion resistant; over 30 per cent chrome, carbon 2 to 3; ordinarily machinable only by grinding. General Alloys Co., Boston.

Additions to listings:

R

- - 3 - - - - - - - -

RCF; a chrome nickel alloy possessing wear resisting qualities. George H. Smith Steel Casting Co., Milwaukee.

- - 3 4 - - - - - - -

RED ANCHOR; carbon 1.05; drill rod ground ready for use for shafts, pins, etc.; drawn squares for keys and special drawn shapes to avoid excessive machining. Anchor Drawn Steel Co., Latrobe, Pa.

- - - - - - - - - - 10

RESILIA; a special analysis silico-manganese spring steel. Bethlehem Steel Co., Bethlehem, Pa.

- - 3 4 - - - - - - -

RESISTO-LOY; a hard-surfacing alloy with chromium 4, nickel 3.2, cobalt 11, tungsten 17, copper 59.19, lead .01, iron 2, arsenic-sulphur .08, silicon .01 phosphorus .03, manganese 1.5 per cent; for application by electric arc or oxyacetylene to shovel teeth, third rail shoes, agricultural machinery parts, etc. Resisto-Loy Co., Grand Rapids, Mich.

1 2 3 4 5 - - - - -

RITA; chrome nickel steels for high strength, wearing qualities and toughness; resistant to corrosion and heat.

Cannon-Stein Steel Corp., Syracuse, N. Y.

1 - 3 4 5 6 7 8 - -

RIVERSIDE; beryllium copper, a heat treatable copper alloy; for electrical applications, springs, diaphragms, jet tips, valve sleeves and seats, etc.; properties include high resistance to corrosion and abrasion, high tensile strength and ductility. Phosphor bronze; copper tin .alloy to which phosphorus has been added; resistant to corrosion, and wear, has high strength and ductility; used in electrical appliances and machinery as bearings, springs, diaphragms, textile ring travelers, etc. Nickel silver; copper, nickel, zinc in varying proportions; for diaphragms, radio and telephone springs, screw machine products, etc. Riverside Metal Co., Riverside, N. J.

1 - - 4 5 6 - - - -

ROMAN BRONZE; copper 60, tin .75, zinc 39.25; high strength and ductility, corrosion resistant; for forging, flanging, upsetting, piston rods, shafting and other machine parts. Revere Copper & Bronze Inc., New York.

1 - - 4 - - - - 9 -

RUSELITE; chromium 1¼ to 1½ per cent, molybdenum .10 per cent, copper 3½, balance aluminum; for die castings and sand castings that ordinarily would be chromium plated. Ruselite Corp., Milwaukee.

Additions to listings:

S

- - - - - - 6 - - - -

SABECO; bearing bronze; No. 5; copper 69 to 71, tin 4.5 to 5.5, lead 24 to 26, max. impurities .25 per cent. No. 9; copper 69 to 71, tin 8.5 to 9.5, lead 20 to 22, max. impurities .25. No. 11; copper 69 to 71, tin 10.50 to 11.50, lead 18 to 20, max. impurities .25 per cent; for spindle bearings, water lubricated bearings, seal noses on bellows seals. Fredericksen Co., Saginaw, Mich.

- - - - - - 6 - - - -

SATCO; white metal bearing alloy; high melting point; nondeforming; suitable for die casting; primary application is bearing liners. National Lead Co., New York.

- - 3 4 5 - - 8 - -

SEMINOLE; grade 42; chromium 1.30, tungsten 2, vanadium .25; for high creep strength bolts and studs for super heated steam; also machine parts having high wear and fatigue values. Ludlum Steel Co., Watervliet, N. Y.

1 - - - - - - - - - -

SEYMOURITE; copper 64, nickel 18 and zinc 18 per cent. Seymour Mfg. Co., Seymour, Conn.

1 2 3 - - - - - - - -

SHAWINIGAN NIROSTA; chrome nickel steels, for applications where heat and corrosion are encountered. Shawinigan Chemicals Ltd., Montreal, Que.

- - - 4 5 - - - - -

SIMPLEX; forging steel; nickel 1.25, chromium .75; used for machine parts where high strength and toughness are required; also available in case carburizing type. Crucible Steel Co., of America, New York.

- - - - - - - 7 - - 10

SMITHCO DYNAMO; an alloy steel possessing high magnetic permeability. George H. Smith Steel Casting Co., Milwaukee.

1 2 3 - - - - - - - -

STAINLESS; "A"; for wearing parts requiring a stainless steel; carbon .30, chromium 13.50 per cent. "B"; also corrosion, abrasion resistant; carbon .65, chromium 16.50. "F.M.S."; carbon .12 max., chromium 13.50; for machined parts where a corrosion, heat resistant material is required. "N"; carbon .12 max., chromium 18, nickel 8.50; for parts requiring high resistance to corrosion, 410 and 410F; carbon .12 max., chromium 13.50; nickel .80; for corrosion resistance. Vanadium Alloy Steel Co., Latrobe, Pa., and Colonial Steel Co., Monaca, Pa., are producers.

- 2 - - - - - - - - -

STANDARD-ALLOY; a chromium-nickel alloy; 20 to 60 nickel, 16 to 25 per cent chromium for heat resisting castings. Standard Alloy Co., Cleveland.

- - - - - - 6 - - - -

STANNUM BABBITT; tin base babbitt for bearings. Lumen Bearing Co., Buffalo.

1 2 3 4 5 - - - - - 10

STERLING; type A; carbon over .12, chromium 12 to 15; maximum resistance to corrosion secured by hardening. Type B; harder than type A. Type BHH; extra hard, carbon 1.05, chromium 17, for ball races, valve parts, bearing surfaces. T; high tensile strength; when treated possesses balance between strength, toughness, machinability and corrosion resistance, for valves, pump rods, pistons, etc. TX; for turbine blading. FC; for applications where free cutting properties are required. M; soft ductile steel, requires no heat treatment to secure corrosion resistance. MG; used where strength and toughness are secondary to workability and high temperature resistance. Nirosta KA2; for oil and chemical industries, in hard wire makes excellent springs. Nirosta KA2S; malleable for hot and cold working. Nirosta FC; free machining 18-8 type in which machinability has been obtained without sacrificing corrosion resistance, strength, toughness. Firth-Sterling Steel Co., McKeesport, Pa., is the producer.

- - - - - - 6 - - - -

SUMET; bronze bearing metals; SM-4; lead 28 per cent, for light and medium duty at high speed. SM-8; lead 26; for moderately severe service. SM-10; lead 24; for bearings subject to shock and impact. SM-12; lead 22; for slow speed under heavy load and impact. SM-14; lead 14; for severe service subjected to heavy shock. SM-16; lead 20; for heavy duty slow speed service. SM-18; lead 17½; for extremely severe service; uses include roll neck bearings; also suitable for gear blanks. Produced by Sumet Corp., Buffalo.

- - 3 4 5 - - - - -

SUPERLOY; No. 4; chrome molybdenum steel for gears, pistons, and heavy duty service where exceptionally high strength and resistance to wear is required. No. 7; 12 per cent manganese steel and 1.25 carbon; for liner plates for ball and rod mills, mantles for gyratory crushers, hammers for hammer mills, jaw plates, roll shells, dipper teeth, tractor shoes, chain, pumps, conveyors, gears, sheaves, etc. Washington Iron Works, Seattle, Wash.

- 2 - 4 - - - - - -

SUPERTEMP; an alloy steel having tensile strength at high temperature; suitable for bolts and studs for reaction chambers, cracking stills, superheaters, etc. Bethlehem Steel Co., Bethlehem, Pa.

1 2 3 4 5 - - - - - -

SWEETALOY; No. 16, 18 per cent chromium iron. No. 17; 18 per cent chromium and 8 per cent nickel. No. 18; 22 nickel and 10 per cent chromium. No. 19; 28 per cent chromium. No. 20; 36 per cent nickel and 18 chromium. No. 21; 65 nickel and 15 chromium. No. 22; 28 chromium and 10 per cent nickel; for castings for chemical plants, paper mills, oil refineries, textile, food product indus-

tries, etc. Cooper Alloy Foundry Co., Elizabeth, N. J.

Additions to listings:

T

1 - - - - - - - - - - -

TAM ALLOYS; a line of ferrous alloys including ferro carbon-titanium; 7.5 per cent carbon. Standard low carbon ferro-titanium; .2 per cent carbon, etc. for rolled, cast and forged steels, stainless and alloy steels and cast iron. Also alloys of varying analyses for special purposes. Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

1 - 3 - - - - - - - -

TANTIRON; 84.9 per cent iron, 13.5 silicon, .8 to 1 carbon, .4 manganese, .18 phosphorus and .05 sulphur; castings for vessels, liners, inserts, chutes, troughs, feed pipes, etc. Bethlehem Foundry & Machine Co., Bethlehem, Pa.

1 - 3 4 - - - 8 - -

TEMPALOY; B; copper 91.2, aluminum 4, silicon .8 nickel 4. Grade C; copper 87.1, iron .25, manganese .50, aluminum 6.75, silicon .90, nickel 4.50. Principal application of these alloys is those instances where a heat treatable alloy is required for strength and resistance to corrosion. Particular uses include motorboat shafting and piston rods. American Brass Co., Waterbury, Conn.

- 2 3 - - - - - - - -

TEMP ALLOY; chrome alloy heat resisting cast iron used for furnaces and other designs subject to high temperatures and abrasion. Continental Roll & Steel Foundry Co., East Chicago, Ind.

- - 3 4 - - - 8 - -

TETON; grade 32; carbon 1, chromium 1.40; for balls and ball races, bushings, cams, etc. Ludlum Steel Co., Watervliet, N. Y.

1 2 - - - - - - - - 10

THERMALLOY; Grade A; oxidation resistance combined with good strength, 55 to 65 nickel, 15 to 20 chromium; for retorts, cyanide pots. Grade B; maximum operating temperature 2050 degrees Fahr.; 35 to 40 nickel, 15 to 18 chromium; for rollers, chain, skid rails, disks. Grade C; 20 to 30 chromium, nickel under 2 per cent; used in chemical industry, for rabble arms and blades on furnaces where easily machinable chromium iron is necessary; with nickel up to 12 for pump parts, valves, rolling mill guides, etc. Rustless irons; low carbon straight chromium iron and 18-8 for corrosion and chemical resistance principally. Electro-Alloys Co., Elyria, O.

- - 3 - 5 - - - - -

TIGERLOY; nickel-molybdenum; for shovel castings, gears, crane track wheels, castings for impact resistance. Massillon Steel Casting Co., Massillon, O.

- 2 3 - - - - - - - -

TIMANG; nickel manganese steel; can be rolled, drawn, forged or shaped; for journal box liners, pedestal gib liners, conveyor flights, welding rod, etc. Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

- 2 - 4 - - - - - -

TIMKEN 17-22 STEEL; exceptionally

high tensile strength and good resistance to creep up to 1200 degrees Fahr.; carbon .40 to .50, manganese .30 to .60, silicon .50 to 1, chrome 1.10 to 1.40, tungsten .80 to 1, vanadium .25 to .35; suitable for highly stressed bolts, studs, screws in high temperature service. The steel can be air treated to meet the mechanical properties. Timken Steel & Tube Co., Canton, O.

1 - - - - - - - - - -

TISCO; corrosion resistant stainless steel castings of all compositions. Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

1 - - - - - - - - - -

TONCAN; an iron alloyed with copper and molybdenum; corrosion resistant. Republic Steel Corp., Youngstown, O.

1 2 - - - - 7 - - -

TOPHET; type A; intended primarily for electrical uses; heat and corrosion resistant, containing approximately 80 per cent nickel and 20 chromium; for electrical heating applications. Type C; also for electrical uses and is heat resistant, being made up of nickel, chromium and iron; for electrical resistance and heating applications. Gilby Wire Co., Newark, N. J.

- - 3 4 - - - - - -

TUFALOY; an alloy cast steel possessing a high yield point and wear resisting qualities. Fort Pitt Steel Casting Co., McKeesport, Pa.

1 - 3 4 - - - - - -

TUF-STUF; copper 87 per cent, iron 3 and aluminum 10 per cent; for application where high tensile strength, resistance to abrasion and to sulphuric acid is required. Mueller Brass Co., Port Huron, Mich.

Additions to listings:

U

1 2 - - - - - - - -

UNILOY; No. 1; noncorrosive, heat resisting up to 1600 degrees Fahr.; chromium 18, nickel 8 per cent. No. 2; noncorrosive, heat resisting to 1800 degrees Fahr.; chromium 21, nickel 12. No. 1409; noncorrosive stainless iron; chromium 12 to 14, carbon .1 per cent. No. 1809; noncorrosive high chrome stainless iron; chromium 16 to 18, carbon .1 per cent. No. 2825; noncorrosive iron; heat resisting to 2000 degrees Fahr.; chromium 28 per cent. Cyclops Steel Co., Titusville, Pa.

- - - 4 5 - - - - -

UNIVAN; nickel vanadium alloy, the primary property of which is high ductility; for locomotive frames, crossheads, coupling boxes, driving wheel centers, etc. Union Steel Casting Co., Pittsburgh.

1 2 - - - - - - - -

USS; stainless and heat resisting steels. Type 4/6 CR; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6. Type 4/6 CR-MO; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6, molybdenum .40 to .65. The two above types can be furnished in .10, .20, and .25 carbon. Type 4/6 CR-T; carbon .15, manganese .60, phosphorus .03, sulphur .03, silicon .50, chromium 4 to 6, titanium is 5 times the minimum carbon content. USS 12, carbon .10, manganese .50, phosphorus .03, sul-

phur .03, silicon .50, chromium 11.50 to 14. No. 17; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 16 to 19. No. 21; carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 20 to 24. No. 27, carbon .10, manganese .50, phosphorus .03, sulphur .03, silicon .50, chromium 25 to 30. 18-8; carbon .15, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 17 to 20, nickel 8 to 12. 18-8S; carbon .07, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 17 to 20, nickel 8 to 12. Stabilized 18-8; carbon .12, titanium 5 times the minimum carbon content, remaining analysis similar to 18-8S; developed to provide a steel in which intergranular corrosion adjacent to welds is prevented. 19-9; carbon .20, manganese .50, phosphorus .03, sulphur .03, silicon .75, chromium 18 min., nickel 8 min. 20-10; carbon .20, manganese .50, phosphorus .03, sulphur. 03, silicon .75, chromium 19 min., nickel 9 min. 25-12; carbon .25, manganese 2.00, phosphorus .03, sulphur .03, silicon .75, chromium 22 to 28, nickel 12 to 16. United States Steel Corp. subsidiaries, including American Sheet & Tin Plate Co., American Steel & Wire Co., Carnegie Steel Co., Illinois Steel Co., National Tube Co.

Additions to listings:

1 - 3 - - - - - - - - -

VANCORAM; ferro-alloys of vanadium, silicon, chromium and titanium; silico-manganese, tungsten and molybdenum; resistant to corrosion and wear; for a wide variety of applications as machine parts. Vanadium Corp. of America, New York.

- - - 4 5 - - - - -

VASCO VANADIUM; carbon from .45 to .95, chromium .90, vanadium .18; for parts requiring high strength and toughness. Vanadium-Alloy Steel Co., Latrobe, Pa.

Additions to listings:

W

- - 3 - - - - 8 - 10

WANDO; oil hardening steel; carbon .95, manganese 1.05, chromium .50 per cent; nondeforming, hardens uniformly; has abrasion resisting properties. Cyclops Steel Co., Titusville, Pa.

Additions to listings:

V

- - - - - 6 - - - -

VANADIUM BB; carbon 1.00, chromium 1.40, vanadium .20 per cent; for bearings and races. Vanadium-Alloy Steel Co., Latrobe, Pa.

X

- 2 - - - - - - - - -

X-ITE; 37 to 39 nickel, 17 to 19 chromium; for furnace parts where not subjected to alternate heating and cool-

ing cycles; standard material for commercial heat treating furnace parts. General Alloys Co., Boston.

Additions to listings:

Y

Additions to listings:

Z

- - - - - - - - - - 10

ZAMAK; die casting alloys; No. 2; aluminum 4.10, copper 2.70, magnesium .03, balance Horsehead zinc. No. 3; aluminum 4.10, magnesium .04 balance zinc. No. 5; aluminum 4.10, copper 1.00, magnesium .03, balance zinc. These alloys are employed for a wide range of machine parts in the form of die castings. New Jersey Zinc Co. Inc., New York.

- 2 - - - - - - - - -

ZORITE; nickel 35, iron 17, chromium 15, manganese 1.75, and carbon 0.5 per cent; resistant to high temperatures. Michiana Products Corp., Michigan City, Ind.

1 - 3 4 5 - - - - -

Z-RON; heat treated white iron (spheroidized); for underground bolts, hydraulic castings, gears, chain, connecting rods, and other machine parts. Gunite Foundries Corp., Rockford, Ill.

Additions to listings:

MACHINE DESIGN
is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

Published by

THE JOHNSON PUBLISHING CO.

Penton Bldg. Cleveland, O.